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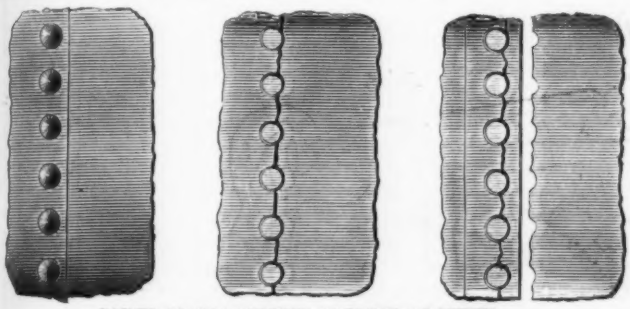
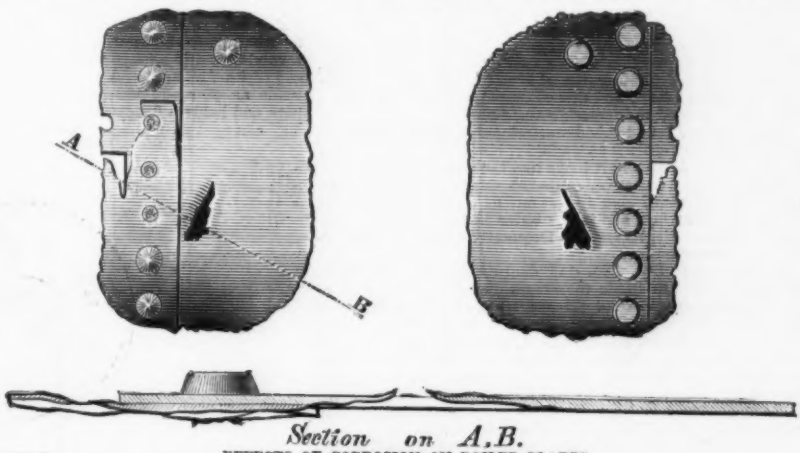
EXHIBIT OF THE HARTFORD STEAM-BOILER AND INSURANCE COMPANY.

Among the most useful exhibits in the Exhibition are those of the above company—useful, not on account of any intrinsic value in the articles themselves, but in the important lessons they convey, touching the practical management of the great working force, the grand prime mover of all our industrial mechanisms—the steam-boiler. The Hartford company has done invaluable service in placing before the public the observations of its officers, in their stated examinations of boilers. They have deposited in the Exhibition various specimens of defective boilers, accompanied by the most convincing data, showing how boiler accidents occur, and how they may be avoided. We will give here a few extracts from these data, with engravings of some of the Centennial exhibits.

The Hartford Steam-Boiler Inspection and Insurance Company was chartered by the Legislature of Connecticut, in 1866. The company has twenty-seven men in its employ, who are wholly occupied with the business of making steam-boiler inspections. Since its organization its inspectors have made 150,042 separate examinations. This includes internal and external inspections. These examinations have developed 16,764 dangerous defects—defects which needed immediate attention, and which would doubtless have led, sooner or later, to explosion. During this time 788 boilers have been condemned, as worn out and unsafe to run. The company's record shows that there have been 848 explosions in the past ten years in this country, by which 1768 persons have been killed, and 1904 more or less wounded. Of the boilers under the care of this company during the past ten years, 18 have exploded, doing damage ranging in each case from $1,800 to $5,000. These boilers were used in the following occupations: iron works, 8; planing mills, 2; railroad locomotives, 2; cotton mill, 1; chrome works, 1; mowing-machine works, 1; hat factory, 1; hotel, 1; tug-boat, 1. By these explosions fifteen persons were killed. Most of these explosions can be easily accounted for. In the iron works, in one case the boiler was fed by a plunger pump, driven by the engine. The packing in the piston being disarranged, the engine was stopped to readjust it. It required more time than was expected, and the fires being kept up in the boiler, the water became low, and the fire-sheets were burned. The boiler exploded directly after starting up the engine. In four other cases of explosions in iron works the boilers were fired by the waste gases from the furnace. The hangings of the boilers gave way, throwing the weight on to other supports, which were not sufficient to sustain them, and the boilers were broken in the girth seams.



BOILER PLATES CRUSHED IN FRONT OF RIVETS.



Section on A.B.

EFFECTS OF CORROSION ON BOILER PLATES.

HOW GAS-HEATED BOILERS SHOULD BE SET.

There was formerly a great error in the hanging of iron-works boilers. They were supported at three points—namely, at the ends and in the middle. This practice was followed with boilers fifty feet long. It will be seen that boilers hung in this way, and fired by a stream of gas, licking their entire length, will be expanded on the bottom. The effect of this will be to curve the ends up, and throw the whole weight on to the centre support. Boilers hung over furnaces fed by gas should have a support once in ten feet at least. It cost us some $10,000 to find this fact out. There are some expensive hangings in the country, where equalizing bars are used, but these are not in general use yet. In the chrome works, while repairs were being made, the workman drove a wooden plug into the steam outlet, to prevent water dripping upon him, the boiler being in a battery, and the stop-valve slightly leaking. When repairs were completed, he went away, forgetting to remove the plug. The boiler was filled with water, and fires started. In about four hours it exploded, killing one man and wounding several; the damage was heavy. In one of the locomotives a defect was found in the iron in the water-leg, and in another the safety-valve was inoperative under any safe-working pressure, from some maladjustment which could not be explained. It was charged that some discharged engineer had tampered with it. The tug-boat explosion was caused by the tug having a very heavy tow in a storm, entering Chicago harbor. The water was thrown off the crown sheet; it was burned, and came down. All of these exploded boilers were regarded as in good condition at the inspection preceding the accident; these explosions were occasioned by some unforeseen circumstance which inspection could not have prevented. The insurance or guarantee was, however, binding upon the company, and in every instance was paid, to the satisfaction of the assured.

During the past sixteen months the number of inspections made was 44,763. The hydraulic test was applied in 3149 cases, mostly new boilers in the yards of manufacturers. The work has brought to light many defects that it will be well for steam users to consider. They go to show that boilers are often on the verge of disaster, when a feeling of security prevails.

The defects in all discovered were 24,040, of which 6149 needed immediate attention, and were set down as dangerous.

The cases of furnaces out of shape were 1058—172 dangerous. Fractures, 1893—884 dangerous.

These defects are usually in consequence of bad management. The boilers are over-heated, and suddenly cooled. Cold water is often fed into a hot boiler where the water is very low, and portions of hot tubes and flues are exposed. The inevitable result is fractures of greater or less extent. This difficulty is liable to manifest itself at the riveted joints, which are the weakest points in the boiler. If from poor workmanship the plates are over-strained at the riveted joints, fractures will most certainly follow. Sometimes they run along the line of the rivets from one hole to another, while at others they run from the hole to the edge of the plate. For instance, by using "drift pins," by which to bring the holes in the sheets to coincide, the fracture may be started.

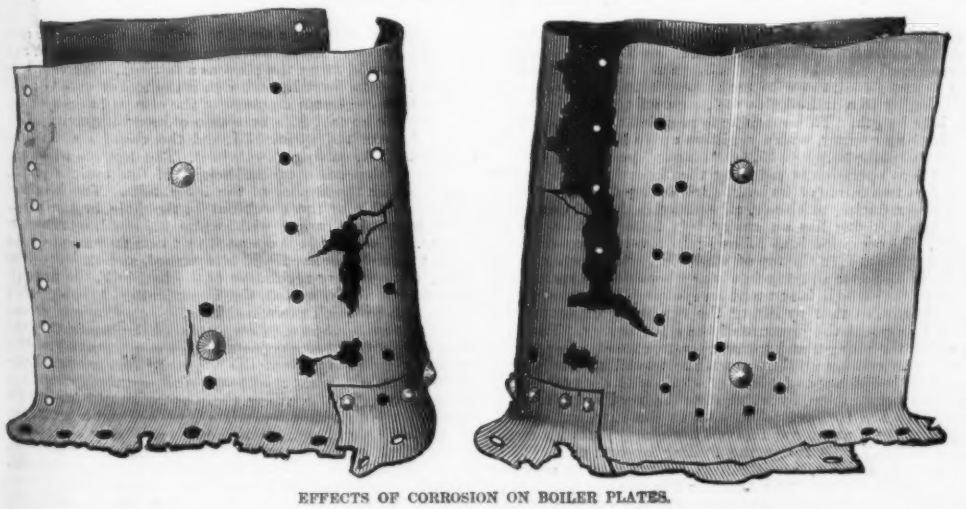
In one instance the iron of the plate is crushed in front of the rivet, while in the other case the plate outside the rivet has broken through to the edge. A case came under our notice some time since where a plate was cracked in the line of the rivet-holes. The boiler leaked, and the owner had it caulked, but it continued to leak. Internal inspection discovered the cause. The defect is here illustrated, by an inside and outside view of the piece cut out. The left-hand or outside view, it will be noticed, has all the appearances of having a perfect joint. These cases are not uncommon, and if from defective workmanship the difficulty is incipient in the boiler, the wear and tear resulting from use will soon develop it in dangerous form.

Burned plates, 1465—552 dangerous. These defects are occasioned by urging fires too fiercely, too small boiler capacity, and accumulation of sediment and scale.

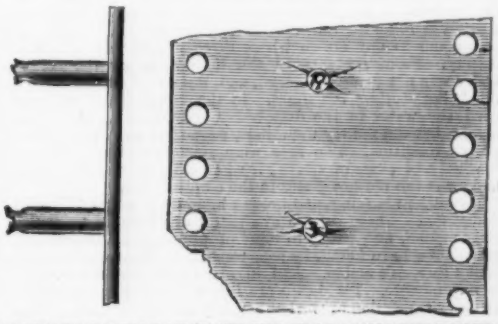
Blistered plates, 3623—670 dangerous. This defect arises from a laminated sheet which is always liable to be over-heated in consequence of the resistance to the conduction of heat, occasioned by the want of homogeneity or soundness. When such a sheet is found on the fire surfaces, it should be at once removed and a new one substituted. Patching, where any considerable portion of the sheet is affected, is poor economy.

Cases of deposit of sediment, 3172—607 dangerous. Incrustation and scale, 3643—558 dangerous. These defects are the very worst which boilers are liable to. Most waters used in steam-boilers contain solid matter in solution, which is precipitated by heat. This matter deposits on the bottom, crown-sheet, or flues of the boiler, and if not speedily blown out, it burns on and forms a hard scale. If this scale is allowed to remain, it prevents the heat from passing readily through the iron to the water, and the result is the iron is badly burned. In a former report (1874) I discussed this subject quite fully, therefore will not occupy time or space for its repetition.

External corrosion, 1538—533 dangerous. Internal corrosion, 681—199 dangerous. The work of corrosion is insidious, whether it is external or internal. A boiler that is set in brick-work may leak at the seams, and corrode the plates adjoining, and yet there may be no indication of danger. So, by the use of impure water, a very dangerous process may be going on inside the boiler. In boilers covered more or less with scale, its presence is often detected by red streaks where the scale is cracked. It attacks the edges of plates at the joints, and around the rivet heads. Sometimes it will attack two boilers working side by side. One will be corroded in the front part, and the other in the back part. Sometimes different sheets in the same boiler will be corroded, while others remain intact. Again, boilers will be found in what is known as a "*pitted*" condition. This is manifested by small spots in close contact being eaten into the sheet. It



EFFECTS OF CORROSION ON BOILER PLATES.



CORRODED PORTION OF WATER-LEG OF A LOCOMOTIVE BOILER.

looks like a pock-marked face and is sometimes confluent; and what is strange about this is, that often certain sheets in the boiler will be attacked, while others will remain clean and smooth, and the iron will bear the same brand on each plate. It is well known that iron ore even from the same mine is not always chemically the same; certain impurities will be found in some places which do not exist in others. And in the manufacture of boiler iron there is no doubt but that the sheets are chemically slightly different; hence when the boiler is constructed the presence of acids in the water may excite galvanic action. This would account for the different manner in which boilers are affected. Engravings on the previous page illustrate the effects of corrosion.

One of the above is a portion of the water-leg of a steamboat boiler—the condition of which was discovered by inspection. The relic is deposited at the Centennial. It is in many spots corroded to the thinness of paper. It had been patched, but there was not metal enough to hold the patches securely. This steamboat was used in summer as an excursion boat, and thousands of people rode over the boilers in the condition represented above. (The patches are removed.) There are doubtless a great many similar cases, which may, in some measure, account for the fearful accidents that appall the country from time to time. Another case of corrosion is also illustrated.

This was discovered by inspection. The outer and inner side of the sheet is shown in the drawing; also a cross-section. The hole in the centre of the sheet was made by the inspector's chisel. The iron was little thicker than paper. The piece of plate is also at the Centennial.

Our next engraving illustrates a portion of the inner plate of a water-leg of a locomotive boiler. Corrosion attacked the plate around the stay-bolts, as represented by the radiating dark lines. The other end of the stay-bolts was eaten nearly off. We judge from appearances, that in tapping out the holes for the stay-bolts, a strain was brought to bear which disturbed the fibre of the iron, or perhaps the skin of the iron, imperceptibly however, to the casual observer.

The difficulty was further aggravated by the unequal expansion and contraction of the two sides of the water-leg. The inner sheet forming the side of the fire-box was subjected to greater heat, and this continual, though imperceptible action, assisted in increasing the difficulty.

Impure water found this disturbed point the most open to attack, and the result is as we find it here. The furrows are eaten in quite deep, and it looks like the work of a tool.

Water-gauges defective, 961—232 dangerous. These attachments are very liable to get out of order. They should be carefully watched, and if the water is bad they should be cleaned often. Engineers are frequently deceived by an inoperative water-gauge.

Blow-out defective, 335—143 dangerous. The valves in this apparatus are liable to disarrangement from pieces of scale lodging on the seats. Hence, when the boiler has been blown out and refilled, if the valve does not close tightly, the water will leak out imperceptibly, and damage will result from overheating. Engineers should never fail to ascertain the condition of the water in their boilers the first thing upon entering the boiler-room in the morning. Never start the fires until this has been done. A great many boilers have been permanently injured by neglect of this rule.

Safety-valves overloaded and out of order, 625—273 dangerous. In one instance the safety-valve was found inoperative and so fast that no allowable pressure could have started it. The boiler to which it was attached exploded, doing large damage. We have found several instances where, from corrosion of valve-guides or stems, they were inoperative at the pressure designated. They were in good condition originally, but from neglect between the inspector's visits, they were found as above indicated. A safety-valve should be raised every day. It is very little trouble to do it. The usual number of cases where the valve was overloaded have been found. Some boiler-tenders seem to think an escape of steam from the safety-valve is dangerous, and they hang pieces of iron on the lever, or bricks, or any thing that comes handy. We have found several cases where the escape-pipes from the safety-valves were too small, or where they were stopped up entirely.

Pressure-gauges out of order, 2868—649 dangerous. The variations of these were from − 45 to + 70. When a gauge is neglected and implicitly trusted, the condition of things is liable to be very dangerous. Gauges need inspection as much as boilers, and their true condition can only be ascertained by careful comparison with a gauge known to be correct.

Boilers without gauges, 811—19 dangerous. Those indicated as dangerous were where high pressures were used. Every boiler should be provided with some reliable means of ascertaining the pressure of steam.

Deficiency of water, 196—93 dangerous. These cases are from different causes. They may result from too limited boiler capacity for the amount of steam required. Leaks are a fruitful cause, and as has already been stated, the valve of the blowout is sometimes prevented from closing tight, on account of some foreign substance lodging upon its seat. A case came to our notice where three boilers were set in a battery. From some cause the blow-valve of the centre boiler was not perfectly seated, and the water leaked out of this boiler during the night. In the morning the engineer tried the water in the first boiler and found it at proper height, but did not try the others, supposing they must be in proper condition. The fires were started, and when steam reached a pressure of 48 lbs., it was sufficient to force down and burst the red-hot plates in the empty boiler.

Insufficient bracing, and broken braces and stays, 968—485 dangerous. These defects are partly attributable to faulty construction, and partly to want of proper examination and care. We have found, in some cases, the stays nearly eaten off by corrosive action. And in many instances the bracing is very meagre. Flat heads are left without support, so that at every revolution of the engine they move to and fro. This process soon develops fractures at or near the joint uniting the head with the shell. Sometimes, however, fractures will occur in the body of the head itself. There are rules for the proper bracing of boilers, and they should not be overlooked.

BOILER EXPLOSIONS.

The record of explosions kept in this office since our last annual report shows 139, by which 191 persons were killed, and 267 wounded. This record in detail is as follows:

		Killed.	Wounded.
Railroad locomotives	23	40	51
Steamboats and tugs	18	30	31
Saw mills	17	34	52
Shingle and planing mills	4	3	10
Iron works and mines	9	16	28
Paper mills and flour mills	9	10	16
Portable boilers	6	4	10
Threshing machines	9	28	10
Dwelling house and kitchen	4	1	6
Furniture manufacturers	3	2	0
Salt works	3	1	4
Miscellaneous	34	22	49

In the miscellaneous list were shoe, tack, soap, belting, organ, and hat factories; rubber, oil, and file works; cotton and woollen mills, etc.

THE MANUFACTURE OF SEWING-MACHINE NEEDLES AT THE CENTENNIAL.

THE National Needle Company, of Springfield, Mass., exhibit in Machinery Hall the entire process of sewing-machine-needle manufacture. The coils of steel wire, from which the needles are made, lie horizontally upon a vertical frame, and thence pass to the straightening, heading, and cutting machine. The wire first passes through an eye provided in a small upright lug at the extreme end of the machine; and, after passing over a bunch of oiled waste, it enters the straightening device. This consists of a frame provided with a spindle, revolving in two uprights providing journal-bearing, the spindles of the frame being parallel, so that it has lateral movement. The body of the frame, which stands between the two end spindles, has on each side three projecting pieces, each one projecting a trifle past the centre of the width of the frame, and each with a small half-round groove in its end to retain the wire in its proper position on the end of the projecting piece. The wire, after leaving the oiled waste above referred to, passes through the hollow end of the frame and over the ends of the projecting pieces; thence through the hollow end of the frame at the opposite end, whence it passes into a circular clamp formed of two disks of iron containing a series of fine grooves of varying sizes to suit different diameters of wire. This clamp is operated reciprocally, and on its forward stroke it pulls with it the wire together with the straightening frame, which latter is kept revolving continuously. When the clamp has arrived at the end of its forward stroke it releases its hold upon the wire, while another and independently actuated clamp seizes the wire and holds it firmly while the disk clamp and straightening clamp travel back, the latter thus performing its straightening on the back stroke only. The second clamp holds the wire stationary, while a horizontal bevel cutter, operated independently, bevels off the end. The instant the bevelling is completed, the wire recommences to revolve, and a tool, similar to a lathe-knife tool, cuts off the needle to the requisite length. This machine is provided at the back with a self-acting counter, which registers up to 10,000. The machine will make 25,000 to 35,000 "blanks" per day.

The next operation is reducing the diameter of the needle for about two thirds of its length from the point end. There are three reducing machines, all similar in design, excepting that the last one has an emery belt instead of an emery wheel. The operation is as follows: In a vertical column is a long vertical slot, in the top of which is a spiral spring about ⅛ inch in diameter and 6 inches long; beneath the spring is a plunger, into which is screwed an eye projecting through a separate slot, so that by lifting the eye the plunger may be lifted up against the pressure of the spiral spring. The slot, in which the plunger and spring operate, extends clear to the foot of the column until it meets the travelling chain feed. This feed is composed of plates of steel, with slots extending half way across them, by which slots the needles are carried. The plates are fastened to an endless chain, which at each end passes over a roller and travels horizontally until it meets those rollers. This forms the feeding apparatus, which is operated by a screw, into which at intervals teeth attached to the feed-comb fit. The operator lifts the eye attached to the plunger, and inserts into the vertical slot the needles one after the other, with the points standing outwards. The needles are pressed down to the bottom of the slot by the spiral spring, and rest upon the chain feed until a slot, passing a needle, falls into it, and is carried along by it. The slots are at intervals of about ⅛ inch, and give a comb-like appearance to the steel feed-plates. Top and bottom of the feed-plates are two separate steel plates operated reciprocally, and with the direction of their movements at all times exactly opposite. The result of these movements is that, while the needle blanks are carried along in a continuous direction, as it were, between the teeth of a comb whose thickness is slightly less than the diameter of the needles, the motion of the steel plates, top and bottom, causes them to, at the same time, rotate back and forth. The needles enter the comb-plates, and are covered by the top and bottom plates only to such part of their lengths as is intended to be left parallel, that part intended to be reduced projecting outwards, and passing on an emery wheel or roller, revolving at a high speed, and operating along the length of the rotating needle to the distance the size of the needle wire requires reducing in diameter. The second reducer operates and performs precisely the same duty as the first, while the third is intended to put on a finish rather than cut away much metal. A blower is connected by pipes to each of these reducers so as to keep them clear of the steel cuttings.

The needles are next pointed in a machine of similar construction to the above-described reducers, except that the revolving emery wheel has no horizontal or lateral movement, and that the needles, instead of standing about at a right angle to the centre line of the length of the emery roller, stand at a considerable angle, so as to grind the point a straight and not a hollow taper. This machine will point about 20,000 needles in a day.

The next operation is that of cutting the groove along each side of the needle eye. This groove is in the Singer needle, which kind was being made upon the occasion of our inspection, longer on the one side than on the other. Each needle is gripped separately horizontally in a small chuck fast to a sliding-carriage; the chuck opens and closes instantly by a cam movement. Upon each side of this chuck stands a horizontally revolving circular milling tool or cutter. When the needle is chucked the sliding carriage is pushed back by the operator, and is automatically fed forward; the cutters, operated by a cam movement, cut the groove on each side, one leaving the needle before the other so as to leave a long and a short groove. The capacity of this machine is 1500 on one machine per day. One operator attends to two machines. The milling tools used for this purpose are made by a very effective, simple, and admirable machine, designed by the Singer Sewing Machine Company, and illustrated in our engraving by Fig. 1, in which A represents a blank cutter, which is a disk of sheet steel of a suitable thickness for the required width of groove to be cut; it is here shown with a few of the teeth already cut. It is held by a nut and a washer fast upon a mandril, to the other end of which is fastened the notch-wheel B, there being as many notches upon the wheel as there are intended to be teeth in the cutter. *c* represents a steel cutter or chisel having a groove running along its front face, as shown at the end view, Fig. 2, and fastened by the clamping device D to the lever E.

Fig 1.

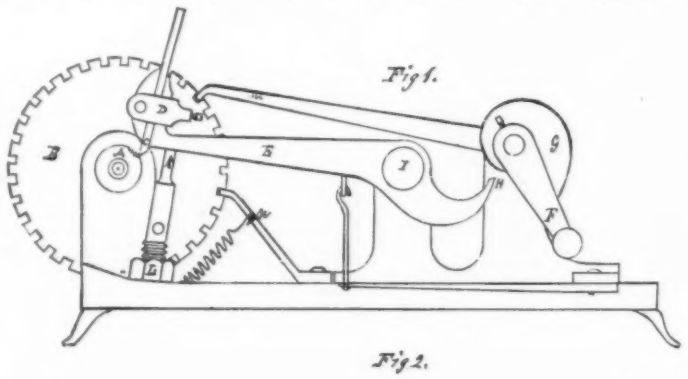


Fig 2.

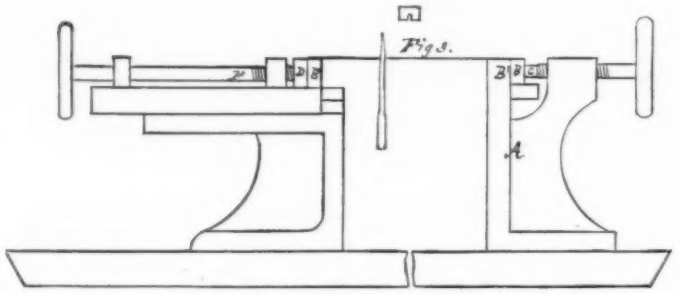


Fig 3.

NEEDLE MACHINERY AT THE EXHIBITION.

F is a handle operating a shaft, to which is attached the cam G, which, as it revolves, meets the end H of the lever E, and by depressing it, using the pin I as a fulcrum, elevates or lifts the end E of the lever E, and with it the tool or chisel *c*; but so soon as the extreme diameter of the cam G has passed the end H of the lever it falls by reason of its own gravity added to the force of the spring J J, and the chisel *c* strikes the cutter blank A, cutting a tooth in it. The depth to which the tooth is cut depends upon the height of the upright pin K, against which the bottom of the lever falls. The height of K is adjustable by the check-nut L, the hole in the pin K being provided to turn it with, while the nut L remains stationary. The lever M is operated by a cam movement on the shaft, to which the handle F is attached, and its duty is to move, during every revolution of the handle F, the wheel B forward one notch, so that the blank cutter A, being bolted to the shaft to which the wheel B is attached, moves around sufficient to receive at each revolution of the handle the blow from the cutter chisel *c* necessary to form a tooth. The duty of the lever *n* is to prevent the wheel B from moving backwards, or from moving at all save, when operated forwards by the lever *m*. Thus it will be seen that by simply turning the handle F the cutter teeth can be cut all one width apart, and of one depth and shape. Here, however, we may observe that the machine will not cut the last tooth, because the blow would break it out, from the weakness arising from the existence of the tooth behind it. This last tooth therefore requires to be cut by hand. The machine cuts the teeth sufficiently correctly that they are all ready to be hardened, and is one of the simplest and most effective devices imaginable.

The next process is that of punching the needle eyes, which is performed in a small hand apparatus operated by a boy. The die in which the needle lies is made in three pieces, the middle one projecting so that it will fit into the groove along the needle eye, and thus form a guide to hold the needle in the correct position. The boy places the needle in the die and moves the point up to a stop, which insures that the eye shall be made the requisite distance from the point. The punch is driven through the needle by a light blow, and the burr left on the underneath side is removed by hand. One boy can punch 10,000 needle eyes in a day. The needles are now ready to be hardened, and about 2000 of them are placed in an iron box and placed in a small brick furnace, whose draft is provided by a chimney and not by a blast of air, which

would burn the needle points on account of the rapidity with which they would heat. They are heated by charcoal to a red heat just insufficient to cause them to scale, and are then quenched in sperm or whale oil which is kept cold by surrounding it by water. In the tempering, which is the next operation performed, the oil is heated to about 440° Fah., and the needles are dropped in and left to boil, a single needle being occasionally taken out and tried, the temperature of the oil being increased very slowly indeed. When the temper is found to be correct the perforated tray containing the needles is lifted from the heated oil and allowed to cool. The tempering oil deteriorates after a time, and is then used for hardening purposes.

The next operation is termed burring. The operator takes in his hand about 24 needles at a time and applies them upon an emery belt running over a ¼-inch spindle, the belt having emery of a grade of 120 glued upon its surface. They are next placed in an arranging clamp, being placed in a row endwise against a stop with the eyes all standing one way. While held in this position they are transferred to a pair of clamp hand pliers having a jaw about 2½ inches wide, the needles projecting points and eyes outwards. In this position they are held upon a revolving brass-wire brush supplied with No. 120 emery mixed with oil. The same process is then repeated upon a bristle brush. Both these brushes are about 7 inches in diameter, and run 3500 revolutions per minute. The next process is to transfer them, without moving their relative positions, into another clamp formed of two strips of iron about ⅜ by ⅜ inches, and 6 inches long, tightened by thumb-screws, and they are threaded upon threads of unbleached cotton which are fastened in the eye-polishing machine illustrated in Fig. 3 of our engraving, in which A represents a head provided with a movable clamping strip B, operated by the screw C, the threads being clamped between the clamp-strip B and the jaw B′. At the other end the thread is held in like manner by the clamp D forced against the jaw E by the screw F, the needles being threaded upon the cotton while held in the clamp, and worked by hand along the cotton threads in all positions, while the threads are supplied with flour emery and oil. This operation is to smooth out the eyes and prevent them from cutting the thread when in use.

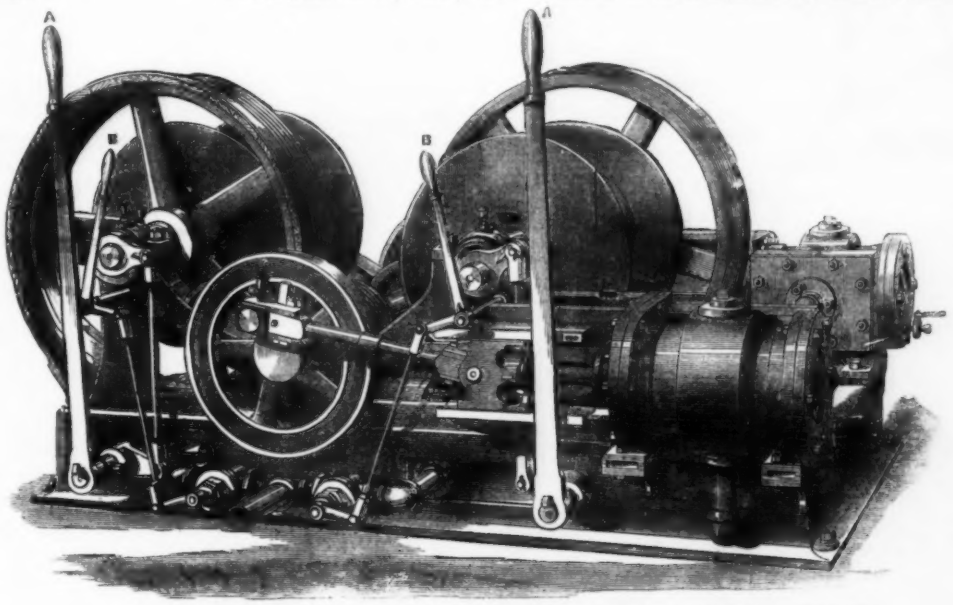
They are next straightened upon an iron block faced with hard rubber. The operator rolls them along to find the bend, and straightens with a light hammer.

We now come to the repointing, which is done on a 4-inch emery wheel running about 4000 revolutions per minute. The operator takes about 18 needles between the forefinger of one hand and the thumb of the other, and using the remaining thumb, on top of the first-mentioned, as a fulcrum, operates the forefinger laterally, giving the needles a rotary motion back and forth. In adjusting the needles he puts all the points against the edge of the bench to bring them even. In applying the needles to the emery wheel, the operator permits them to contact with it on the forward movement of his fingers only. The wheel used is a wooden one covered with emery, one half No. 120 and one half flour, glued to it.

The final finishing is performed on a brush buff-wheel, supplied with dry crocus, although a little alcohol is sometimes used. The final operation is the lettering and numbering.

The needles are inspected after every operation when made by piece-work, and after the eye-polishing and straightening when made by day's-work.

J. R.



THE INTERNATIONAL EXHIBITION OF 1876.—WILLIAMSON'S HOISTING ENGINE.

EXHIBITION NOTES.

FRICTIONAL GEARED HOISTING ENGINE.

WE give a perspective view of a hoisting engine constructed by Messrs. Williamson Brothers, of Philadelphia, the same as shown at the Centennial Exhibition, save that the latter engine is provided with a single cylinder only, this cylinder being 8 in. in diameter with 8 in. stroke. Messrs. Williamson Brothers are extensive makers of hoisting machinery, and the engine illustrated is of their patent double-drum frictional geared type, the two drums working quite independently of each other. The drums are started and stopped by turning eccentric bearings, which bring the frictional geared wheel on each drum shaft into or out of contact with the corresponding pinion on the driving shaft. The eccentric bearings are respectively operated by the levers A A, there being a separate lever to each drum, and these levers not merely turning the eccentric bearings, but also applying or loosing the brakes and closing or opening the governor valves. The arrangement is such that by a movement of one of the levers A the gearing is moved out of contact, while a further movement in the same direction applies the brake and shuts off steam by means of the governor valve. In addition to the governor valve just mentioned, there is for each cylinder a stop valve operated by the lever B, this stop valve being employed for adjusting the supply of steam to the load to be lifted. There is also provided for each cylinder a kind of byepass or starting valve, by means of which steam can be admitted to the cylinder without passing the governor valve. This valve is also used for starting the engine, and it also serves to enable the engine to be kept running slowly when the frictional gear is out of contact and the governor valve closed.—*Engineering.*

POWER PRESSES AT THE CENTENNIAL.

THE exhibit of Messrs. Bliss & Williams in the Centennial Machinery Hall includes their upright and incline power presses, a double-acting power blacking-box press, a double-acting cam power press, a power drawing press, and a spinning lathe. In machines not worked by power, they exhibit a No. 1 lever press, a blacking-box beader, a squaring shears, a solder cutter, a soldering block, and a loose gate solder mould.

The incline power press, shown in Fig. 1, is so constructed that the work which does not drop through the die will pass off of itself without any aid of the operator. The height and position of the dies enable the operator to stand in an easy position, so that the operation of feeding is not fatiguing. The mechanical movements of the machine may be plainly understood from our illustration, and we need only mention that the spring-barrel attachment consists of a long spring encased in an iron barrel. The lower die is supported by this spring, and as a consequence the pressure due to the stamping is graduated, avoiding sudden strains or jumping; added to which, it permits more time to elapse during the stamping process, thus saving the dies, while, on the back stroke, it forces the work out from the lower die, and thus permits it to fall in the box without aid from the operator. It also holds the blank until the stamping punch performs its duty. The pressure of the spring can be regulated to suit different kinds of work. The height of the blankholder, and hence the position of the stroke, can be regulated by the right and left hand steel screw, and the check nuts shown. The driving shaft is of steel, 3 inches in diameter, the distance between the bearings being 7 inches. All the bolt screws upon the machine are of steel, and are, with the nuts, case-hardened. The action of the machine is smooth and even, evidencing care in the construction. It is shown in operation at the Centennial, and cuts the blanks, forms them, and stamps them at one operation; and it is here that the advantages of the spring barrel become apparent, since it gives the tin time to conform itself to the stamping dies, thus avoiding injury to the metal plates. The capacity of the machine is about 18,000 covers per day.

The double-acting power blacking-box press, shown in Fig. 2, has been recently introduced. It is driven by a horizontal shaft at the back, driving the pinion which operates the gear wheel on the main shaft. The wheels are geared in the proportion of 4 to 1. The driving pulley is 14 inches in diameter, and has a 3½-inch face; the balance wheel is 26 inches in diameter, and weighs 240 lbs. The machine is designed to run at 160 revolutions per minute. The round opening in the bed is 6 inches in diameter, the length of stroke of the cutting punch being ¾ inch, while that of the drawing punch is 2 inches. The distance from the bed to the bottom of the slide when the latter is up is 5½ inches, and the machine complete weighs about 2800 lbs. The first thing about this machine that attracts the attention of the mechanic is the excellence of the gearing, which having cast teeth is stronger than one with cut teeth. The form of the teeth is English, being what is known as the Manchester tooth. It is deeper than the ordinary form of tooth, and is considered stronger. These gears run very quietly, and the bearing on the teeth shows even and uniform. The cutting punch is operated by a cam upon the main shaft, while the drawing punch is operated by a crank-pin on the side of the cam, operating a lever, by which motion is given to the drawing punch. The cam itself operates between two rollers, one above and one below, but both are held upon the same frame or lever. The upper roller is attached to the lever operating the blankholder, and acts to give the latter its downward stroke; while the lower roller acts upon the same frame to give to the blankholder a back stroke. The connection between the crank-pin and the lever operating the plunger or drawing punch is made by a right and left hand screw connection made of steel, case-hardened, and provided with check nuts. The operation of the press is as follows: The cutting punch is bolted to the blankholder, and descends and cuts out the blank; the blankholder remains stationary, retaining the blank on the lower die until the plunger or drawing punch descends and forces the blacking-box through the die into the box beneath. The lever operating the blankholder is depressed under the resisting action of a rubber spring, which prevents any jumping of the lever from a too sudden transition of the power imparted to it, and keeps the wear on the lower side of the cam; and the play is therefore taken up during the back stroke of the blankholder, which is an excellent feature of the machine, as the action becomes easy and quiet, even if the parts are considerably worn.

The power drawing press shown in Fig. 3 weighs about 6200 lbs.; the size of the round opening in the bed is 11 inches. The distance from the bottom of the blankholder (when it is at the end of the up stroke) to the bed is 8 inches. The length of the stroke of the blankholder is 3 inches, and that of the drawing punch is 6 inches. It will receive a blank up to 15 inches, and a drawing punch up to 11 inches, in diameter. The balance wheel is 37 inches in diameter, and weighs 600 lbs.; it is geared in proportion of 6 to 1, the driving pulley (of 20 inches diameter and 5 inches face) being designed to make 180 revolutions per minute.

The arrangement of the parts of this machine will be readily understood by reference to our illustration. The driving shaft is at the back of the pinion, which gear into the spur wheel. Upon the main shaft are two cams, operating the blankholder; and between them, and on the same shaft, is the crank operating the drawing punch. The blankholder is adjustable by means of the screws and check nuts upon the rods, imparting to it the motion from the cams. This press is shown in operation making three-quart pans, the diameter of the blanks being 11⅛ inches. The operation of the machine is as follows: The lower die is always made of the same diameter as the size of the blanks for the ware to be stamped. By this means the operator is enabled, by bringing the edge of the blank fair with the circumference of the die, to set the blanks true in the machine without requiring to use any great care in adjusting on the die. The blankholder descends and holds the blank in position, while the drawing punch forces it the necessary distance into the lower die. In the middle of the latter is a table supported by a spiral spring, the duty of which is to force the ware out of the lower die as the blankholder rises. On examining one of the pans thus pressed, it will be found that, while the tin on the bottom shows no evidences of having been operated upon at all, the sides and flange are slightly crimped, and the metal is actually thickened by the operation of stamping. The surface of the tin, however, remains perfect. To take out the crimps, trim the edges and bead the edge. The pans pass from the above machine to the spinning lathe shown in Fig. 4. The driving head, it will be seen, is similar to that of an ordinary lathe with the cone pulley turned around, which is done so that, when the belt is on the pulley nearest to the operator, it shall be on the smallest cone, and therefore most out of the way of the operator. The cone or taper chuck which rotates the ware is screwed to the lathe spindle in the usual manner; the back-head spindle is operated in and out by a simple lever, which locks itself when the spindle is forward, and pressing against the ware to hold it against the driving chuck, by wedging on the taper end of the projecting piece shown in the engraving, and upon the top edge of which the lever is shown to be resting. By this means the spindle and plate can be operated and locked very quickly. The lathe is provided with a compound slide rest, and by its side, standing crosswise to the bed, is a lever swung upon a pin in the middle of its length. On the front end of this lever is a beader, and on the back end a pair of circle shears. The lever is operated by a hand lever; the height of the circle shears and of the beading roll, and the distance between them, are arranged so that, when the lever stands horizontally, both the beading roll and the circle shears stand clear of the dish-pan on the lathe chuck; but by removing the handle downward, and thus operating the lever, the circle shears are brought into contact with the edge of the dish pan, and cut it off to the requisite diameter, which is regulated by the lever coming into contact with a stop. The motion of the handle, and hence of the lever, is then reversed, and the beading roll contacts with the edge of the dish-pan, and turns it around, leaving a circular bead, the edge being turned entirely in. The operation of the beader is terminated by the lever coming into contact with a stop, so that the cutting and beading are thus made uniform in diameter. The operation is to place the pan upon the mandril, and hold it, by bringing the table or plate on the back spindle into contact with the back face of the dish-pan, holding it to the chuck which revolves the pan by friction. The plate also revolves with the dish-pan by reason of its having a stud at its centre, revolving in the end of the spindle. The spinning tool is operated by the rest worked by hand along the outside of the pan, taking out all the crimps, and leaving the surface true and smooth.

The chuck has upon its larger diameter a flange; and from the spinning operation the flange of the dish-pan is brought into contact with the flange of the chuck, and the former is thereby made to run true. The operator then depresses the handle, which in turn elevates the circling shears which trim and cut the flange of the dish-pan to the proper diameter. The handle is then lifted and the lever motion reversed, bringing the beader into operation; the handle is then moved into middle position, the back-head spindle withdrawn to the position shown in our engraving, and the dish-pan taken from the mandril, finished true and uniform in size, the whole operation occupying but about half a minute.

The largest of our illustrations, Fig. 5, is intended for use in the manufacture of stamped goods. In this country, however, the name stamped goods or stamped ware is hardly appropriate, as in most cases the drop has given way to the press. It is designed for drawing large dish-pans, saucepans, and similar large and deep pressed ware. When driven at a stroke of eight strokes per minute it will carry down two No. 7 dish-pans at a time. In the ordinary method of drawing, it is not desirable to carry a blank down more than 4¼ inches at a time; then the dish is removed and spun to take out the wrinkles, as already described. The spinning hardens the metal, and makes it more liable to crack; and turning up the flange is a useless operation, as it must be turned back in wiring. This press, by reason of its elasticity, draws down so perfectly that spinning, as an intermediate operation, is not needed. The blankholder holds the flange at both operations. After taking the pan down 4¼ inches, it is merely necessary to put in another punch in order to take it down the remainder of the distance. This saves one third of the ordinary operations, and a greater proportion of time, since spinning is a much slower operation than stamping, and at least two extra handlings are involved in finishing the blanks, etc. The usual necessity of assorting the plates is avoided by the use of levers, which spring or give slightly, allowing the blankholder to yield sufficiently to admit the different thicknesses without difficulty, thus greatly reducing the proportion of breakage. The press is driven by means of a friction clutch of an improved and substantial pattern; and by its means the press can be stopped and started almost instantaneously. The strains due to the work are almost entirely taken up by the 3-inch stay rods at the sides of the frames and bed plates. In addition to these, there are four 2¼-inch rods passing from the bed plate to saddles on the shaft which carries the punch lever. These rods take the strain when the dies come home, entirely relieving the bed plate.

In Fig. 6 is shown a single-acting power press, the spindle of which is of steel; the adjusting screw is of steel, and, with the check nuts, it is box hardened.

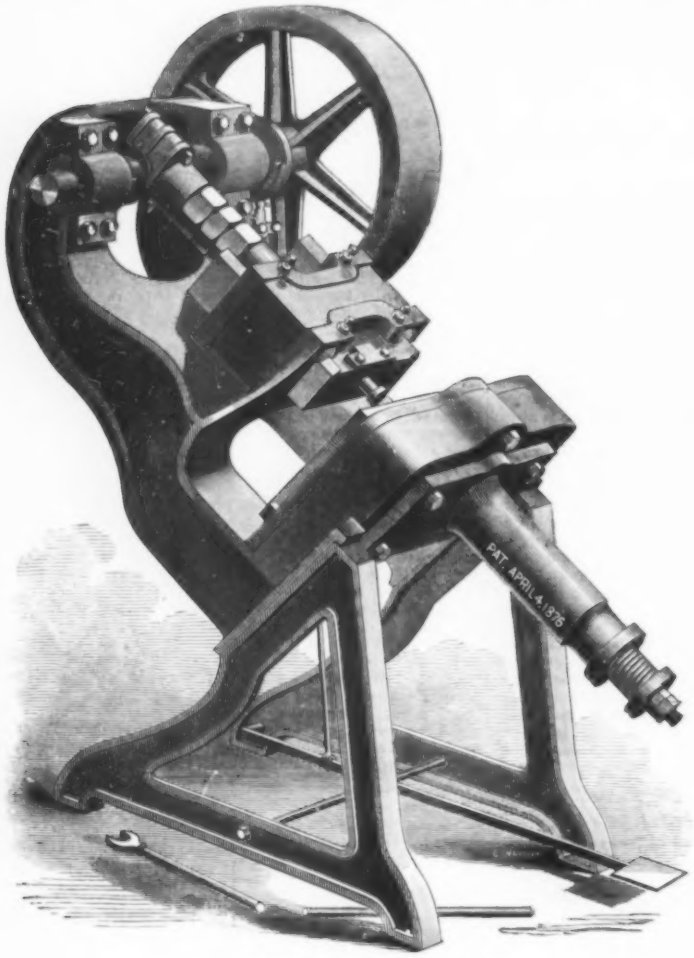


Fig. 1.—INCLINE POWER PRESS.

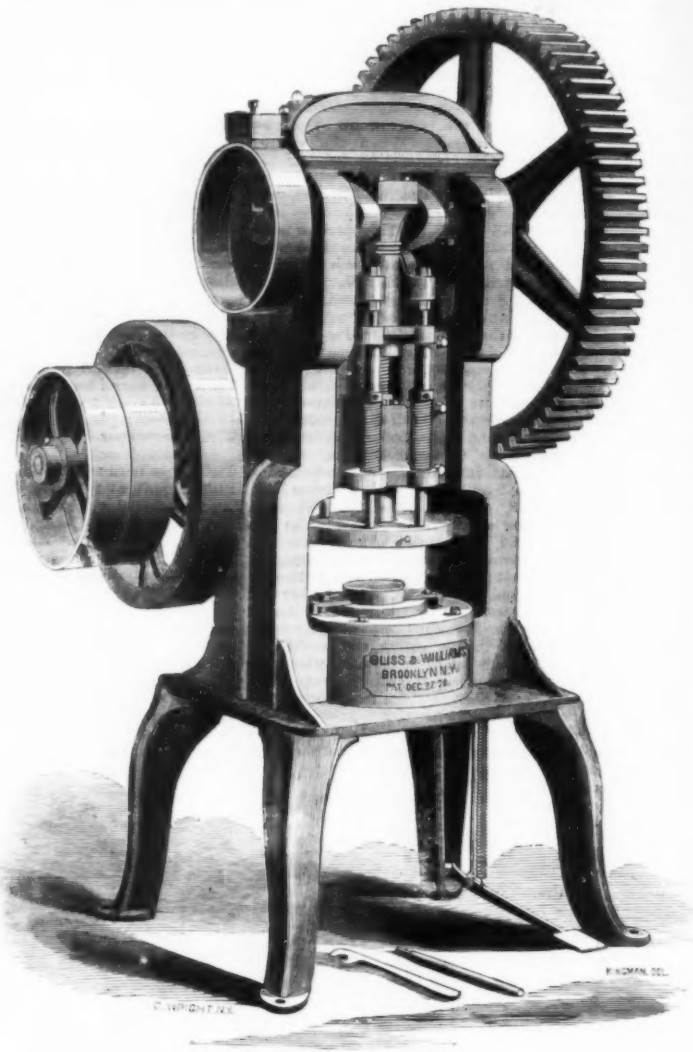


Fig. 3.—POWER DRAWING PRESS.

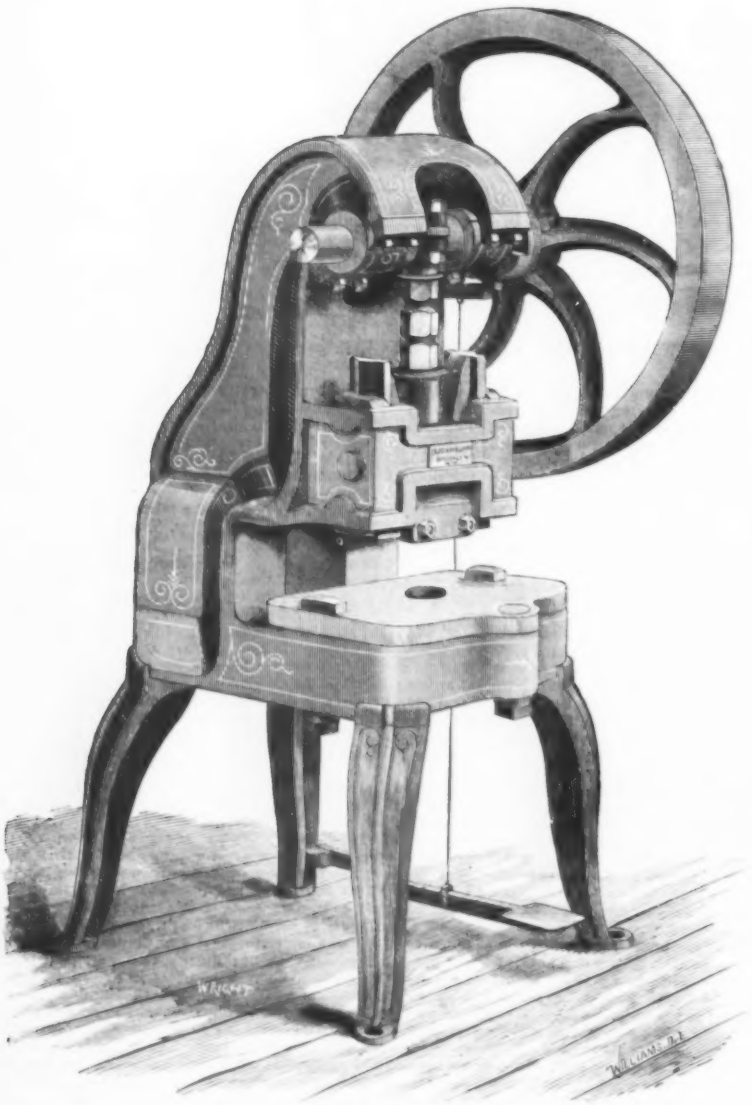


Fig. 6.—SINGLE-ACTING POWER PRESS.

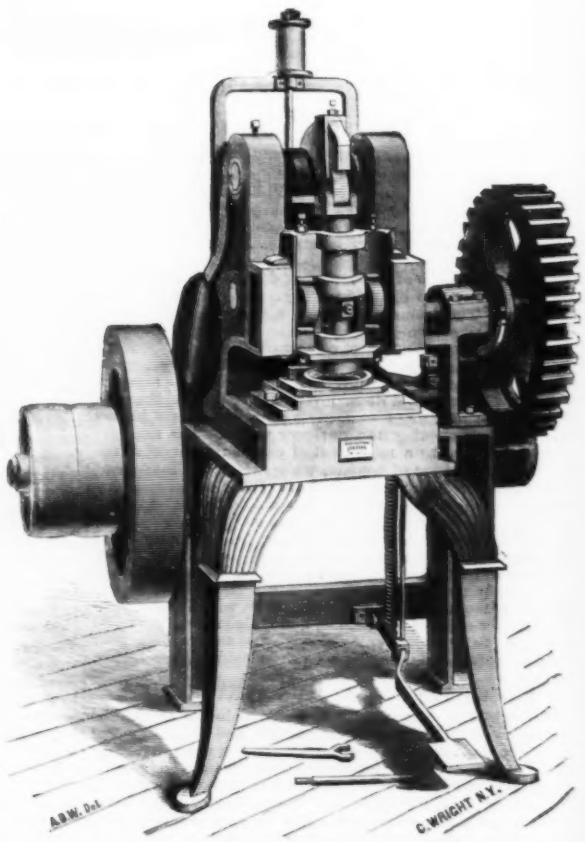


Fig. 2.—POWER BLACKING-BOX PRESS.

THE INTERNATIONAL EXHIBITION OF 1876.—AMERICAN POWER DRAWING PRESSES.

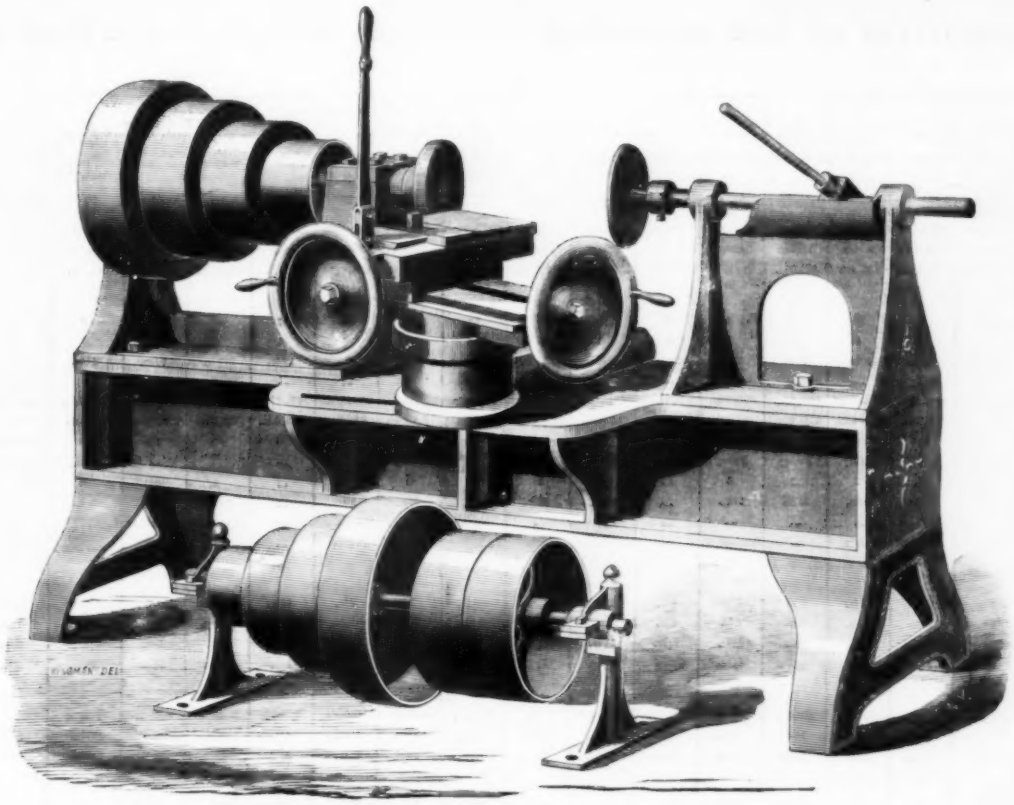


FIG. 4.—SPINNING LATHE.

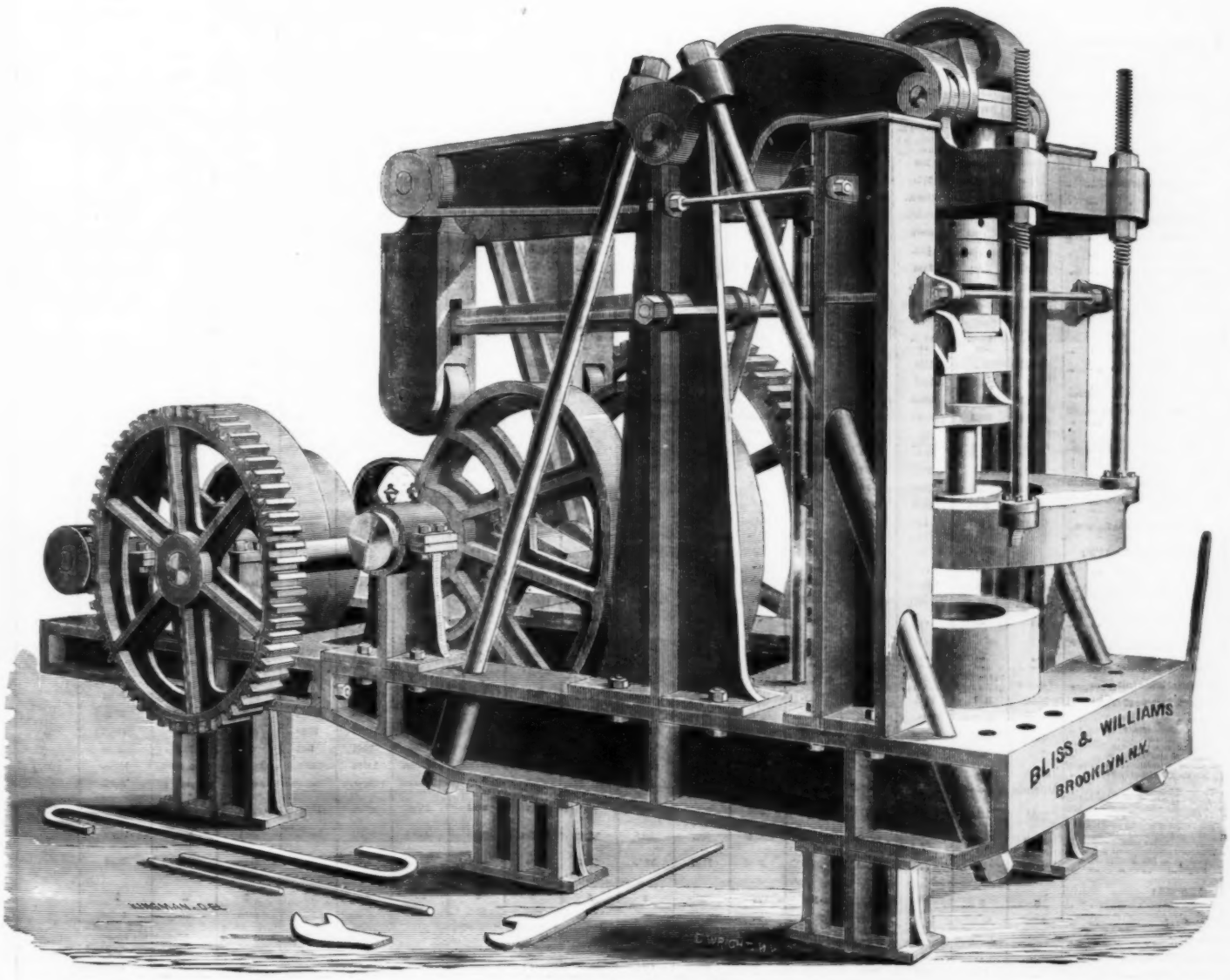


FIG. 5.—POWER DRAWING PRESS.

THE INTERNATIONAL EXHIBITION OF 1876.—AMERICAN POWER DRAWING PRESSES AND LATHES.

LOCOMOTIVES AT THE EXHIBITION.—TABLE OF LEADING PARTICULARS.

No.	REFERENCE NUMBERS OF DIAGRAMS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Name and address of manufacturer	Burnham, Parry, Williams, and Co., Baldwin Locomotive Works, Philadelphia, Pa.								Philadelphia & Reading RR.	The Dickson Manufacturing Company, Scranton, Pa.			Danforth Locomotive Works, Paterson, N.J.		Porter, Bell, & Co., Pittsburgh, Pa.	W. Mason Taunton, Mass.	Rogers' Loco. Machine Works, Paterson, N. J.	Dunnemora Harry's Jernverk, Sweden
2	Railroad for which engine is built	Lehigh Valley Railway	Pennsylvania Railroad		Dom Pedro II. Railroad Brasil	Central Railroad of New Jersey	(a)	West End Railroad,	Passenger) Centennial	Ditto (b)	(c)	(c)	(c)	(d)	(e)	(f)	West End Pass. Ry. Con. Grun.	Mobile & Montgomery Rld.	
3	Whether passenger or freight engine	Freight	Passenger	Freight	Freight	Passenger	Mining	Passenger	Freight (g)	Fast freight	Passenger	Passenger	Mining	Passenger	Freight	Passenger	Passenger (g)	Mixed	
4	Whether tender or tank engine	Tender	Tender	Tender	Tender	Tender	Tank	Tender	Tender	Tender	Tender	Tender	Tank	Tender	Tank	Tender	Tank	Tender	Tank
5	Width of gauge	4 ft. 8½ in.	4 ft. 9 in.	4 in. 8½	5 ft. 3 in.	4 ft. 8½ in.	3 ft. 6 in.	5 ft. 0 in.	5 ft. 0 in.	4 ft. 8½ in.	4 ft. 8½ in.	4 ft. 8½ in.	3 ft. 0 ft.	4 ft. 8½ in.	3 ft. 6 in.	3 ft. 0 in.	3 ft. 0 in.	5 ft. 0 in.	3 ft. 3½ in.
	WHEELS:																		
6	Number of wheels	10	8	10	8	8	4	8	8	10	8	8	4	6	6	6	6	8	8
7	Number of coupled wheels	8	4	8	8	4	4	4	4	6	4	4	4	4	4	4	4	4	6
8	Diameter of coupled wheels	50½ in.	69 in.	50 in.	54 in.	62 in.	30 in.	62 in.	57 in.	54 in.	47 in.	42 in.	29 in.	62½ in.	26 in.	44 in.	30 in.	50½ in. (e e)	31½ in.
9	Diameter of wheels, other than truck wheels, not coupled	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	29½ in.
10	Total wheel base	22 ft. 10 in.	23 ft. 6 in.	23 ft. 4 in.	22 ft. 8 in.	23 ft. 5 in.	9 ft. 10 in.	16 ft. 7 in.	17 ft. 8 in.	20 ft. 8 in.	21 ft. 10 in.	17 ft. 6 in.	4 ft. 6 in.	21 ft. 6½ in.	10 ft. 10 in.	16 ft. 2 in.	21 ft. 8½ in.	21 ft. 6 in.	12 ft. 2 in.
11	Length of rigid wheel base	14 ft. 9 in.	6 ft. 6 in.	13 ft. 6 in.	13 ft. 6 in.	8 ft. 6 in.	3 ft. 10 in.	7 ft. 6 in.	11 ft. 8 in.	17 ft. 8 in. (e)	8 ft. 0 in.	6 ft. 8 in.	4 ft. 6 in.	8 ft. 0 in.	10 ft. 10 in.	8 ft. 6 in.	...	7 ft. 9 in.	5 ft. 10 in.
12	If with truck in front	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Two trucks	Yes	No
13	Type of truck	Bissell	Swing	Swing	Swing	Swing	—	Swing	Swing	Centre bearing	Swing	Swing	—	Centre bearing	—	Swing	Fairlie system	Swing	
14	Number of wheels in truck	2	4	2	2	4	—	4	2	4	4	4	—	4	—	2	4 in each truck	4	
15	Diameter of "	30 in.	29 in.	30 in.	30 in.	29 in.	—	24 in.	24 in.	30 in.	30 in.	24 in.	—	28 in.	—	30 in.	37 in.	26	
16	Materials of main wheels	See Note (f)	Chilled cast iron	—	—	See Note (g)	—	Chilled cast iron		Chilled cast iron	Cast iron bodies and steel tyres			Cast iron & steel tyres		Cast iron & steel tyres Chilled cast iron	—	Cast iron centre and steel tyres Chilled cast iron	
	AXLES AND CRANK BEARINGS:																		
18	Diameter of bearing of driving axle	7 in.	7 in.	6½ in.	7 in.	7 in.	6 in.	5½ in.	5 in.	6½ in.	7 in.	5 in.	4½ in.	6½ in.	4½ in.	5⅝ in.	5⅝ in.	6½ in.	5½ in.
19	Length of "	8 in.	7½ in.	7½ in.	8 in.	8 in.	6 in.	7 in.	7 in.	8 in.	6½ in.	6½ in.	6 in.	7½ in.	6 in.	6½ in.	7 in.	7½ in.	5½ in.
20	Diameter of main crank-pin bearing	5 in.	5½ in.	4½ in.	4½ in.	4½ in.	3½ in.	3½ in.	3½ in.	4½ in.	4½ in.	3 in.	3 in.	4 in.	3 in.	3½ in.	3 in.	3½ in.	3 in.
21	Length of "	5 in.	5½ in	5 in.	4½ in.	4½ in.	3 in.	3½ in.	3½ in.	4 in.	4 in.	3½ in.	3 in.	3½ in.	3½ in.	3½ in.	3 in.	3½ in.	3 in.
	CYLINDERS:																		
22	Position of cylinders	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside	Outside
23	Diameter of "	20 in.	19 in.	20 in.	16 in.	17 in.	8 in.	12 in.	12 in.	16 in.	17 in.	11 in.	9 in.	17 in.	11 in.	14 in.	11 in.	16 in.	11 in.
24	Length of stroke	24 in.	24 in.	24 in.	24 in.	22 in.	12 in.	16 in.	16 in.	24 in.	24 in.	15 in.	12 in.	28 in.	16 in.	24 in.	16 in.	24 in.	16 in.
	VALVES AND VALVE GEAR:																		
25	Length of steam ports	20 in.	20 in.	17½ in.	16 in.	15 in.	7½ in.	10 in.	10 in.	15 in.	16 in.	9½ in.	6 in.	15½ in.	8 in.	...	9 in.	14½ in.	6½ in.
26	Width of "	1¾ in.	1¾ in.	1¾ in.	1¾ in.	1¾ in.	¾ in.	1 in.	1 in.	2¾ in.	1¾ in.	1 in.	¾ in.	1¾ in.	¾ in.	...	1¼ in.	1⅝ in.	1 in.
27	Width of exhaust port	2¾ in.	2½ in.	2½ in.	2¼ in.	2¼ in.	1½ in.	2 in.	2 in.	2¾ in.	2¼ in.	2 in.	1¾ in.	2¾ in.	1¾ in.	...	2¾ in.	2¾ in.	2 in.
28	Outside lap of valve	¾ in.	¾ in.	¾ in.	¾ in.	¾ in.	⅛ in.	¾ in.	⅝ in.	¾ in.	¾ in.	¾ in.	¾ in.	¾ in.	¾ in.	...	⅝ in.	¾ in.	
29	Inside "	⅛ in.	0	0	⅛ in.	⅛ in.	⅛ in.	⅛ in.	⅛ in.	...	⅛ in.	—	—	⅛ in.	...	...	⅛ in.	⅛ in. (d d)	
30	Travel of valve	5½ in.	5 in.	5 in.	5½ in.	5½ in.	2½ in.	4½ in.	4½ in.	4½ in.	...	—	—	...	...	...	4 in.	...	
31	Throw of eccentrics	5 in.	5 in.	5 in.	5 in.	5 in.	2 in.	4½ in.	3½ in.	4½ in.	4½ in.	4½ in.	3 in.	5½ in.	3½ in.	...	7 in. (h)	5 in.	
32	Type of valve gear	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Shifting link	Walschaert	Shifting link	
33	Position of "	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Inside frame	Outside	Inside frame	Outside
	BOILER AND FIREBOX:																		
34	Maximum internal diameter of boiler	67 in.	57½ in.	52½ in.	53 in.	50½ in.	24½ in.	45½ in.	35½ in.	50 in.	49 in.	52½ in.	29½ in.	48 in.	36½ in.	42½ in. (i)	39½ in.	48¼ in.	34½ in.
35	Minimum "	53 in.	48½ in.	53½ in.	50 in.	47½ in.	22½ in.	41½ in.	37½ in.	46 in.	43 in.	33 in.	28½ in.	46½ in.	35½ in.	36½ in. (j)	36½ in.	47 in.	
36	Height of centre of boiler above rails	9 ft. 6½ in.	8 ft. 2 in.	8 ft. 6 in.	8 ft. 1½ in.	9 ft. 2½ in.	5 ft. 6 in.	5 ft. 2 in.	4 ft. 9½ in.	6 ft. 5½ in.	8 ft. 5 in.	4 ft. 11 in.	2 ft. 6½ in.	5 ft. 11½ in.	4 ft. 6½ in.	4 ft. 11 in.	4 ft. 10½ in.	5 ft. 10½ in.	4 ft. 3 in.
37	Length of firebox inside at bottom	9 ft. 10 in.	6 ft. 0½ in.	8 ft. 0 in.	8 ft. 5 in.	8 ft. 4 in.	3 ft. 5 in.	4 ft. 11 in.	4 ft. 6½ in.	8 ft. 0 in.	8 ft. 0 in.	5 ft. 10 in.	3 ft. 10 in.	8 ft. 0 in.	4 ft. 6 in.	8 ft. 0 in.	4 ft. 10½ in.	3 ft. 8 in.	3 ft. 0 in.
38	Width of "	2 ft. 6½ in.	2 ft. 10½ in.	2 ft. 10½ in.	2 ft. 11½ in.	2 ft. 0½ in.	2 ft. 0½ in.	1 ft. 9½ in.	1 ft. 10½ in.	2 ft. 6 in.	2 ft. 0½ in.	1 ft. 6½ in.	1 ft. 11½ in.	2 ft. 10½ in. (k)	1 ft. 8 in.	2 ft. 4 in.	2 ft. 9 in.	2 ft. 11 in.	2 ft. 6 in.
39	Height of firebox crown above grate	7 ft. 1 in. & 6 ft. 10 in. (k)	6 ft. 10 in. & 6 ft. 6 in. (k)	7 ft. 1 in. & 6 ft. 10 in. (k)	7 ft. 1 in. & 6 ft. 10 in. (k)	7 ft. 1 in. & 6 ft. 10 in. (k)	2 ft. 6 in.	3 ft. 11 in.	3 ft. 6 in.	7 ft. 6 in. & 6 ft. 6 in. (k)	6 ft. 1½ in.	2 ft. 11½ in.	2 ft. 4½ in.	5 ft. 1 in. & 4 ft. 10 in. (l)	3 ft. 1 in.	3 ft. 4 in.	5 ft. 3 in.	7 ft. 1 in. & 6 ft. 10 in. (e e)	
40	Number of tubes	180	156	158	159	262	48	112	124	190	183	92	65	175	92	120	98	154	
41	Outside diameter of tubes	2in.	2¼ in.	2¼ in.	2 in.	2 in.	1¾ in.	2 in.	1¾ in.	1¾ in.	2 in.	1¾ in.	1¾ in.	2 in.	1¾ in.	1¾ in.	2 in.	2 in.	
42	Inside "	1.799 in.	2.032 in.	2.260 in.	1.782 in.	1.782 in.	1.334 in.	1.782 in.	1.334 in.	1¼ in.	1½ in.	1⅞ in.	1⅜ in.	1.80	1.56	1¼ in.	1¼ in.	1¼ in.	
43	Length of tubes between tube plates	10 ft. 11 in.	10 ft. 7 in.	12 ft. 10 in.	11 ft. 1½ in.	11 ft. 7 in.	6 ft. 3 in.	9 ft. 4½ in.	8 ft. 0½ in.	11 ft. 6 in.	11 ft. 6 in.	8 ft. 0½ in.	7 ft. 6 in.	10 ft. 5½ in.	6 ft. 11½ in.	7 ft. 11 in.	8 ft. 11 in.	10 ft. 1 in.	8 ft. 11 in.
44	Boiler material	Iron	Steel	Steel	Iron	Steel	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron (m)	Iron	Iron	
45	Thickness of boiler plates	½ in.	⅝ in.	½ in.	½ in.	⅝ in.	¼ in.	⅜ in.	⅜ in.	½ in. & ⅝ in.	½ in. & ⅝ in.	⅜ in. & ½ in.	⅜ in. & ½ in.	{½ in. and ⅝ in. (r)	½ in.	⅜ in. & ½ in. (s)	½ in.	⅜ in.	
46	Tube material	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron	Iron (n)	Iron (n)	Iron (n)	Iron	Iron	Iron	...	Iron, lap welded	
47	Thickness of tubes	.109 in.	.109 in.	.109 in.	.109 in.	.109 in.	.083 in.	.109 in.	.083 in.	⅜ in.	⅛ in.	⅛ in.	⅛ in.	.10	.095	⅜ in.	⅜ in.	⅜ in.	
48	Firebox material	Steel ⅜ in.	Steel ⅜ in.	Steel ⅜ in.	Copper ½ in.	Steel (o)	Steel ½ in.	Steel ⅜ in.	Steel	Steel	Steel	Steel	Steel	Steel ⅝ in. (p)	Steel ⅝ in. (p)	Steel ⅝ in. (q)	Steel	Steel ⅜ in. (r r)	
	HEATING SURFACES:																		
49	Heating surface of firebox	sq. ft. 113	sq. ft. 106	sq. ft. 92	sq. ft. 109	sq. ft. 117	sq. ft. 24	sq. ft. 72	sq. ft. 60	sq. ft. 86	sq. ft. 116.1	sq. ft. 66.75	sq. ft. 22	sq. ft. 101.5 (r)	sq. ft. 49	sq. ft. 55	sq. ft. 58.7	sq. ft. 87	
50	External surface of tubes	1131	971	1159	997	948	208.5	490	391	1242	974.6	514.8	168.7	854.26	291.5	434	410	813	
51	Internal "	1099	871	1057	926	867	193	450	367	894	897	374	154	803	260.2	373	359	711	
52	Total heating surface with external tube surface	1242.2	1077.0	1251.0	1035.0	1065	232.5	562	451	1328.0	1090.8	578.25	229.7	1055.76	340.5	489	468.7	900	
53	Total heating surface with internal tube surface	1212.0	977.0	1149.0	935.0	985.0	217.5	522.0	427.5	980.0	1006.9	537.75	236.0	961.5	309.2	429.5	433.7	799.5	
54	Firegrate area	24 sq. ft.	19 sq. in.	25½ sq. in.	16 sq. in.	24 sq. in.	5 sq. in.	8.5 sq. in.	8.5 sq. in.	29 sq. in.	24.14 sq. in.	10.25 sq. in.	5.0 sq. in.	22.96 sq. in.	6.34 sq. in.	6.38 sq. in.	10 sq. in.	14.45 sq. in.	7.5 sqr. ft.
55	Fine area through full sectional area of tubes	360.	342.39	360.0	350.0	360.87	80.4	276.68	126.6	367.68	436.74	153.6	80.72	444.5	275	214	171	279	
56	Number of "internal" diameters in length of tube	73.3	62.5	67.6	65.0	73.2	26.1	56.21	72.15	92.0	96.15	79.1	67.6	69.51	53.26	82.3	61.1	69.1	
57	External tube surface divided by firebox surface	10.10	9.35	12.03	9.00	8.81	8.44	6.06	6.52	12.12	9.25	4.91	5.89	9.40	3.95	7.89	7.2	8.45	
58	Total heating surface divided by firegrate area	51.79	52.89	53.90	64.37	44.87	26.10	69.12	53.05	40.29	42.96	56.90	39.41	45.96	53.79	77.23	46.87	57.33	
59	Firegrate area divided by fine area	6.67	5.51	5.22	5.14	5.51	11.96	4.30	7.05	11.33	9.15	11.30	5.98	7.44	5.32	4.29	7.82	5.62	
	WEIGHTS OF ENGINE:																		
60	Weight of engine empty	—	—	—	—	—	—	—	—	89,900 lb.	87,500 lb.	36,400 lb.	15,000 lb.	—	27,225 lb.	27,097 lb.	—	53,330 lb.	
61	Weight of engine in working order	102,000 lb.	71,320 lb.	81,440 lb.	80,000 lb.	72,000 lb.	15,000 lb.	42,000 lb.	33,000 lb.	76,832 lb.	71,000 lb.	30,000 lb.	15,800 lb.	—	37,000 lb.	32,000 lb.	—	62,000 lb.	
62	Weight on coupled wheels in working order	82,000 lb.	45,000 lb.	73,400 lb.	69,000 lb.	51,800 lb.	15,000 lb.	28,000 lb.	33,000 lb.	53,536 lb.	47,000 lb.	26,500 lb.	15,800 lb.	—	37,000 lb.	24,000 lb.	abt. 28,000 lb.	40,000 lb.	
63	Weight empty per square foot of heating surface	—	—	—	—	—	—	—	—	61.9	51.8	36.2	71.5	—	72.9	54.9	—	59.4	
	MISCELLANEOUS:																		
64	Contents of coal tanks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2,700 lb.	2500 lb.	
65	Contents of water tanks	—	—	—	—	—	{150 gals. Eng.	—	—	—	—	—	{217 gals. Eng.	—	{627 gals. Eng.	—	600 gals. Eng.		
66	Diameter of blast nozzle	Variable	{2½ in. by ¾ in (s)	{3 in. by ¾ in. (s)	Variable	4½ in. (c)	2½ in. (c)	2½ in. (c)	2½ in. (c)	Variable (c)	3 in. (c)	2½ in. (c)	1¼ in. (y)	2 in	2 in.	—	2½in. to 2 in.	2½ in. and 2¼ in.	
67	Maximum diameter of chimney	18 in.	16 in.	20 in.	17 in.	14 in.	8½ in.	10 in.	10 in.	14 in.	15 in.	11 in.	9 in.	14 in.	22 in.	22 in.	20 in.	16 in.	
68	Minimum "	16 in.	15 in.	20 in.	17 in.	14 in.	8½ in.	10 in.	10 in.	14 in.	15 in.	11 in.	8 in.	14 in.	21 in.	21 in.	21 in.	15 in.	
69	Least sectional area of chimney in square inches	201.06	154.47	314.16	226.98	153.94	38.74	78.54	78.54	153.94	176.72	95.03	50.26	201.06	95.03	89.42	28.83	176.71	
70	Firegrate area divided by least sectional area of chimney	17.1	19.16	10.61	10.15	22.45	20.68	13.58	13.58	26.19	19.67	28.00	18.06	16.44	8.61	9.17	13.15	11.72	
71	Working pressure of steam in pounds per square inch	160 lb.	—	—	130 lb.	130 lb.	117 lb.	135 lb.	135 lb.	130 lb.	130 lb.	130 lb.	130 lb.	160 lb.	140 lb.	120 lb.	130 to 160 lb.	120 lb.	
72	Nature of fuel used	Anthracite	Bituminous	Bit. coal	Bit. coal	Anthracite	Anthracite	Anthracite	Anthracite	Anthracite	Anthracite	Anthracite	Anthracite	Anthracite	Bituminous	Bituminous	Bituminous	Wood	
73	Tractive force for each pound of effective pressure per square inch on pistons	126.9	111.9	232	144	202.55	25.6	54.56	62.27	144	108.1	60.65	29.52	111.04	53.78	84	52.79	108.76	80.72
74	Tractive force with an effective pressure on the pistons equal to four-fifths the boiler pressure	13,022	—	—	14,976	10,065	2262.8	5455	6227	13,612	10,722	5022.8	4008.1	12,486	6100.4	4224	5408	10,430	
75	Tractive force in previous line expressed in per cent. of adhesive weight	15.32	—	—	22.09	20.71	15.07	19.39	17.78	23.67	22.81	21.06	21.19	—	16.51	17.01	23.05	26.13	
	TENDER:																		
76	Number of wheels in tender	8	8	8	8	8	—	8	8	8	8	8	—	8	—	8	—	8	
77	Diameter of "	30 in.	30 in.	30 in.	30 in.	30 in. (C. I. Sol. tyres (o o)	—	24 in.	24 in.	30 in.	33 in.	24 in.	—	30 in.	—	36 in.	—	30 in.	
78	Material of "	{Chilled cast iron	{Chilled cast iron	{Chilled cast iron	{Chilled cast iron		—	{Chilled cast iron	{Chilled cast iron	{Chilled cast iron	{Chilled cast iron	{Chilled cast iron	—	{Chilled cast iron	—	{Chilled cast iron	—	{C.I. chilled tyres	
79	Contents of coal space	—	—	—	—	—	—	—	—	12,000 lb.	10,000 lb.	5000 lb.	—	7924 lb.	—	4000 lb.	—	Capacity 1 cord	
80	Contents of water tanks, Eng. gals.	—	2262	2000	1958	1535	—	884	1000	1986	2000	913	—	1833	—	1000	—	1986	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18

NOTES REFERRING TO THE TABLE.

(*a*). In addition to the locomotives, particulars of which are tabulated here, there are a few others exhibited at the Centennial. Our table, however, includes all shown within the building. Outside the Maryland State Building there are two engines, sent by the Baltimore and Ohio Railway, one the No. 5 of that railway, the other No. 600. The former is one of a class built in 1835, and is with seven others still actively employed on shunting service. It was designed and built by Phineas Davis, of York, Pennsylvania, and has a vertical tubular boiler, fired from the front, through a projecting horizontal firebox, and having two vertical cylinders attached to the rear of the boiler, one on each side. The piston rods of these cylinders are connected with vibrating beams above the top of the boiler, rods being connected to the ends of the beams, and giving motion to two wrought-iron cranks. This motion is transferred through spur gearing to the wheels, which are four in number, and 36 in. in diameter. The reversing gear consists of an ingenious arrangement of sliding cams worked by levers and by the foot. The weight of this machine is about 8 tons, and the working pressure 60 lbs. The whole of the work is remarkably good, and in this respect it forms a striking contrast to the new locomotive, No. 600, which forms a second engine exhibit of the Baltimore and Ohio Railroad. This is a heavy passenger engine of the "Mogul" class, and is built for working the traffic over the steep mountain sections of the railway. It weighs 90,400 lbs., and has six coupled wheels, with cast-iron centres and steel tires, 60 in. in diameter. The cylinders are 19 in. in diameter and 26 in. stroke, and the boiler is 50 in. in diameter. The firebox is of steel.

(*b*). Where no destination is entered in the table, the engines have not been sold.

(*c*). This is a freight engine, but during the period of the Exhibition it will be used in working the traffic on the West End Passenger Railway.

(*d*). This engine is on the single boiler Fairlie system, with two four-wheeled bogies.

(*e*). Measure to centre of truck at forward end.

(*f*). The main wheels on the engines Nos. 1 to 8 have, as is common in American practice, cast-iron centres and steel tires. The tires used are now almost exclusively of American make. They are shrunk on to the body, the amount of shrinkage being $\frac{1}{100}$ in. per foot of diameter of wheel. In some cases the tire is further secured by a number of set screws passing through the rim of the wheel, and entering the tire. These screws are furnished with a nipple at the end about $\frac{1}{4}$ in. in diameter, and $\frac{3}{4}$ in. long, which fits in a corresponding hole in the tire.

(*g*). These wheels are of the Washburne pattern, of cast iron, with steel tires. In making these wheels the latter are heated, and the bodies are cast within them. The tires are rolled with a bulge on the inside, so that the cast body can not slip off. It is, moreover, claimed that a partial fusion takes place on the surfaces of contact between the iron and steel, making the whole wheel one solid mass.

(*h*). This dimension is the travel of the crank, the Walschaert's valve gear being employed.

(*i*). This dimension refers to the wagon top of the boiler.

(*j*). At front end of boiler.

(*k*). That there are two dimensions for the height of the firebox is due to the fact that the grates are inclined, and sometimes the crowns also. The drawings of these engines, which we shall shortly publish, will explain this.

(*l*). The lesser of these dimensions refer to the back of the firebox, and the greater to the front.

(*m*). Pennsylvania charcoal iron.

(*n*). Fastened with copper ferrules.

(*o*). Side sheets $\frac{1}{4}$ in. t ick; back sheets $\frac{7}{16}$ in.

(*p*). The firebox tube sheets in these two engines are $\frac{1}{2}$ in. thick.

(*q*). Crucible steel.

(*r*). Front tube plate $\frac{7}{16}$ in.

(*s*). Wagon top plate, $\frac{1}{2}$ in.

(*t*). In this firebox there is a combustion chamber of 3 cubic feet capacity.

(*u*). These blast nozzles are square. Engines Nos. 2, 3, 7, 8, have double nozzles, of which drawings will be published.

(*v*). These nozzles are single.

(*w*). From $3\frac{1}{2}$ in. to $4\frac{1}{2}$ in.

(*x*). These nozzles are double.

(*y*). Single nozzle.

(*z*). Will burn anthracite during its period of service at the Exhibition.

(*a a*). Washburne wheels.

(*b b*). This engine and tender were built for exhibition by the apprentices in the Reading locomotive shop of the Philadelphia and Reading Railroad.

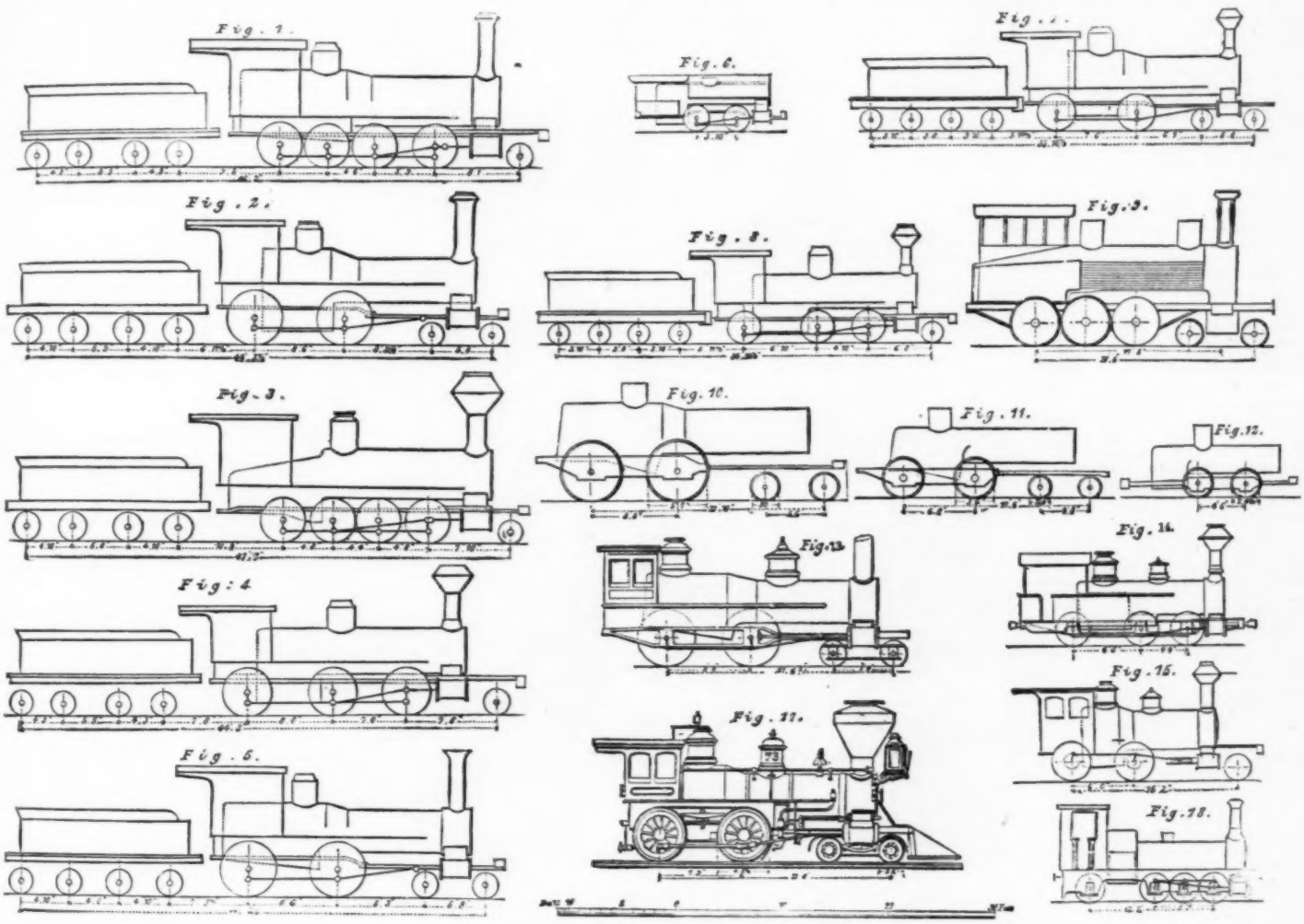
(*c c*). Counterweights are formed entirely in rims of driving wheels, dispensing with weights between spokes.

(*d d*). $\frac{1}{4}$ in. at front and $\frac{1}{2}$ in. at back.

(*e e*). At front.

(*f f*). Tube plate, $\frac{7}{16}$ in.

NOTE.—The Pennsylvania Railroad passenger engine (No. 2 in the table), and all the engines employed in working the traffic on the West End Passenger Railway at the Exhibition, are fitted with the Westinghouse automatic brake, and all the trains for the latter service are also fully equipped with this brake.



THE INTERNATIONAL EXHIBITION OF 1876.—THE LOCOMOTIVE EXHIBIT.

There is also another locomotive built by the Brooks Locomotive Works, employed in working the West End Passenger Railway.

LOCOMOTIVES AT THE EXHIBITION.

THE show of locomotives at Philadelphia is essentially an American one. In fact, with the exception of a small locomotive from Sweden, the whole of the locomotives exhibited are of American construction. That this should be so will no doubt decrease the interest of this section of the Exhibition to American visitors, but by visitors from Europe it will scarcely be regarded as a fault. At the British Exhibition of 1862, at Paris in 1867, and at Vienna in 1873, European railway engineers had good opportunities of studying the varieties of locomotives in use on their own side of the Atlantic, but with the exception of a single locomotive shown at Paris in 1867, American locomotive practice has been entirely unrepresented at each of the exhibitions we have mentioned, and the opportunity now afforded of studying that practice at Philadelphia will therefore be regarded with much interest.

We have prepared a table containing the leading particulars of all the engines shown within the building, and this table we publish with the present number. We also give a series of outline diagrams of the various engines, these diagrams being figured to correspond with the reference numbers at the head of the columns of our table. The diagrams are all drawn to the same scale, so that they not only convey a fair idea of the general arrangements of the engines, but also of their relative sizes.

On reference to the diagrams just mentioned, the most striking feature which will be noticed is the almost universal employment of the bogie. Of the eighteen engines referred to in the table, but four are unprovided with bogies, while of these four, one (the Swedish engine) is fitted with radial axle-boxes, and of the three others two are small four-wheeled tank locomotives. The next feature which will probably be noticed is the large size—and in some cases peculiar form—of the fireboxes employed on the anthracite burning engines. With the exception of the large grates required for the anthracite fuel, however, the proportions of the American locomotive boilers do not differ greatly from those adopted in English practice. As regards the materials, however, there is a striking contrast, but one of the engines exhibited having a copper fire-box, while in the whole of the engines the tubes are of iron. With the single exception mentioned the whole of the fireboxes are of steel.

As regards general arrangement it will be noticed that all the engines have outside cylinders, and—with two exceptions,—inside valve gear, inside cylinders being almost unknown in American practice, while outside valve gear is, so far as we are aware, only used in some narrow-gauge engines. Of the eighteen engines enumerated in the table, eight are for gauges between 3 ft. and 3 ft. 6 in., one of these (made by Mr. W. Mason, of Taunton) being of the Fairlie type, a type of which Mr. Mason has now made a considerable number for use in the United States. The Fairlie engine exhibited, however, has but one steam bogie, the other bogie being merely a carrying truck, not fitted with steam cylinders.—*Engineering*.

A CURIOUS EXPERIMENT.

THE screw steamer Thames, 1687 tons, belonging to Messrs. Temperley, Carter & Co., left the Victoria Docks recently for Montreal, with a very curious arrangement of pumps fitted to her engines, by Mr. R. M. Marchant, of Kirby Street, Hatton Garden, intended to pump back part of the exhaust steam into her boiler, by which means Mr. Marchant hopes to effect a great saving in the expenditure of fuel. He argues that out of every 100 units of fuel ten units are expended in raising a corresponding volume of water from 60° Fah. to 212° Fah., and 65 to evaporate afterwards into steam, and that out of the 25 units left 10 are expended (under the best application) in giving pressure and power to the steam, and 15 are lost by radiation or conduction up the chimney. Thus 85 units of the expended fuel go into the boiler, of which 10 represent the power or pressure in the steam, which is manufactured at the cost of the other 75, and these 10 units of fuel expended for the purpose of pressure in the steam represent the only operating portion of the 100 of expended fuel. He therefore argues that as the application of any power in excess of that represented by the 10 units would recompress and return the steam to the boiler after its pressure has been taken out of it, and that as the compression given to the steam—representing pressure therein—for the purpose of returning it with such pressure in it to the boiler, replaces in the boiler for its repeated use all the pressure so effected, any work on the pumps for such compression is immediately represented in the boiler for application by such attained pressure for the purpose of power in the boiler, that consequently all the work is represented in the boiler less friction, and that, therefore, the attainment by any process of the means of supplying the boiler with steam must necessarily be effected without any loss of power other than that of the free friction of the pumps. This is not very clear, but it is all that we can make of Mr. Marchant's views. The method whereby he proposes to carry his theory into practice, as fitted to the Thames, is thus contrived. A double-acting pump 36 in. in diameter, and 9 in. stroke, takes off from the exhaust steam of the low-pressure cylinder the same volume of steam as is admitted into the high-pressure cylinder at each stroke. This steam being admitted into a reservoir above the

pump, is next forced by one stroke of a similar double-acting pump into a reservoir of half the volume, and by the second stroke of the pump it is again compressed by half its volume, and is sent back into the boiler. In its passage through the pumps the steam is saturated with water, so that it is returned to the boiler in the form of clouds, and all heating of the pumps is avoided. The pistons of the pumps are geared on to the main crank shaft, and Mr. Marchant asserts that the pumps being equally balanced, the steam will be pumped back in a compressed state into the boiler with the same power as is required to pump in the feed-water ordinarily. It is not difficult to see in what Mr. Marchant's mistake lies. It is an instructive fact that any shipowner in the present day should permit a large sea-going steamer to be fitted with what is neither more nor less than "a perpetual-motion engine," the value of which our readers can estimate for themselves.—*The Engineer.*

THE RAILWAY TUNNEL UNDER THE ENGLISH CHANNEL.

THIS gigantic and long-talked-of scheme is one which, however doubtful as a financial speculation, must be admitted at least to be a splendid evidence of the determination and perseverance with which obstacles and impediments are met by the scientific men of the present age. Last year we gave a plan and description of the proposed tunnel, and we then spoke of the work which had been done towards the solution of the problem from the time when it was first mooted in a definitive shape by M. Thomé de Gamond. Since then the progress, though slow, has been encouraging. The soundings and observations taken during last autumn have settled two important points. Firstly, that no break exists in this portion of the layer of chalk, gault, and *craie de Rouen*, which comes to the surface on the bottom of the Channel in the parts where soundings were taken; and secondly, that the "dip" observed in some of the strata nowhere exceeds ten per cent. A belt of soundings from one to five miles broad has been taken from two to four miles west of the line where the tunnel is to be made. This difference, it is explained, is to allow the stratum to "dip" sufficiently to permit of a good thickness between the roof of the tunnel and the bottom of the Channel. The works at Sangatte, shown in our illustration, were commenced in February last by the firm of Mulot Père et Fils et L. Dru, of Paris, the contractors, who set up a shed containing a powerful derrick, a winch, and all the appliances which they had long been accustomed to use in their shaft-sinking operations. The spot selected was but a few yards distant from the beacon marking the shore end of the submarine telegraph cable.

Day and night shifts, each of six workmen and a foreman, have been at work ever since the 25th of February, when the ground was broken, and on Saturday afternoon (June 3) they had reached a depth of 61 mètres—200 English feet—in *craie de Rouen* (gray chalk), which was entered at a depth of 35.95 mètres—118 feet. As one of the objects of these borings is to gauge the amount of water that is likely to be met with in the final operations, the shaft has been lined to a depth of 50 mètres with iron tubing, let in telescope-wise, of different diameters. The first tube is 10.26 mètres long and 4½ centimètres in diameter; the second 17.05 mètres long and 33 centimètres in diameter; the third 23.30 mètres long and 33 centimètres in diameter; and the fourth 50.03 mètres long and 28 centimètres in diameter. The annular space between the tubes has been filled up with cement grouting, to make it watertight and to consolidate the whole.

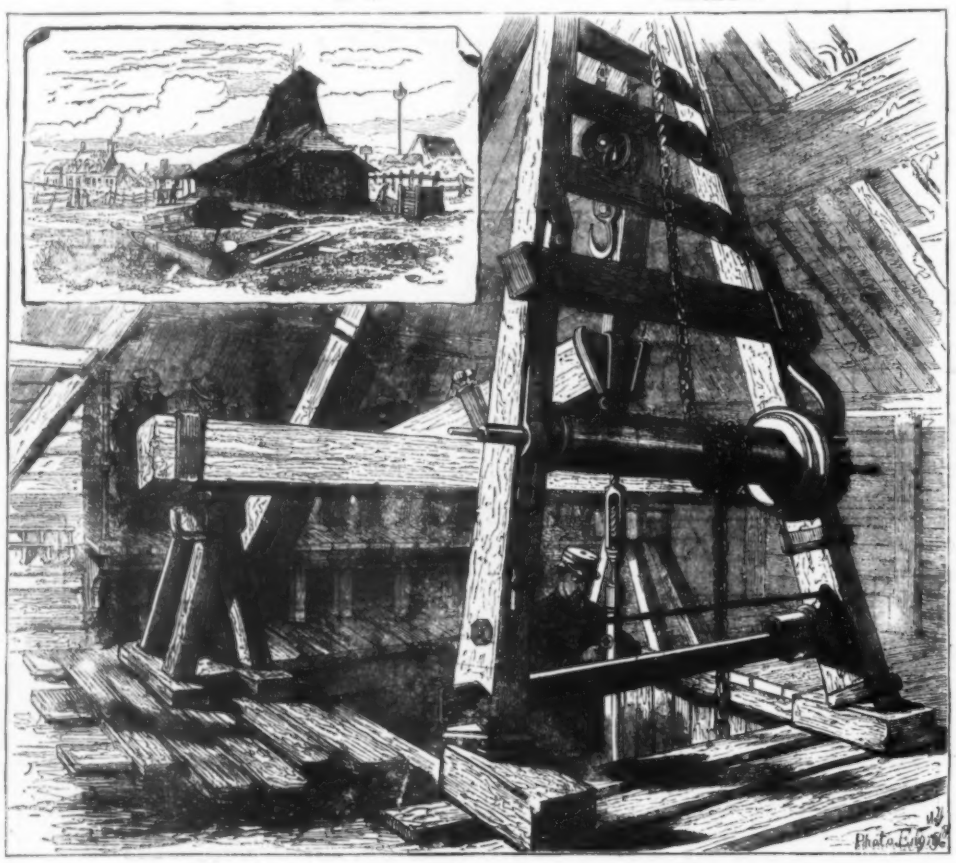
The operations are twofold—first, breaking, turning, twisting, and crushing the ground at the bottom of the shaft by means of an instrument called a trepan, acted upon by a powerful lever; when this has been effected an iron scoop 5 feet long is let down by rods, and turned round till the foreman considers it full, when it is withdrawn. This operation, at 60 mètres, occupies 40 minutes. On reaching the surface the scoop is emptied, its contents carefully examined, and specimens collected; the scoop, after being well washed, is sent down again, the return operation occupying 10 minutes. Two rods only have broken during the whole operation, and these were withdrawn without much difficulty. Two tubular pumps are on the works, the larger one having been discarded since the tubes of 33 and 28 centimètres in diameter have been fixed; the pump with a smaller bore is occasionally sent down the shaft to pump it dry and ascertain the amount of infiltration, which hitherto has been small, and of spring water only, notwithstanding the proximity of the sea.

M. Morin, the Channel Tunnel Company's agent, who was selected for his long acquaintance with the geology of this district, resides close to the works, and has made a complete collection of specimens from the boring, also a series obtained from the different strata which crop up in the neighborhood of Blanc Nez.

The works are directed by M. Henri Baujé, foreman of the firm of Mulot & Dru, an intelligent, quiet, reticent man, whose last work was sinking wells for the Russian Government at Tiflis, the neighborhood of which is rich in mineral waters.

The daily progress of the borings through the upper strata averaged from 50 to 60 centimètres; since reaching the gray chalk (*craie de Rouen*) the rate has increased from 82 to 100 centimètres daily; the greatest progress made in any single day was 2 mètres 50 centimètres in 22 hours. Now that a softer stratum has been reached, progress will be more rapid, and a faster, though less powerful machinery, has recently been substituted for that at first used. As we have already said, such an example of ingenuity, resource, and patient indomitable pluck must command our admiration whether the result be success or failure. Time alone can solve that great question, and that other greater one, whether when completed the tunnel will be sufficiently patronized to pay interest on the enormous capital of £8,000,000 sterling. On the one side it is argued that good sailors would of course have nothing to gain, and that those who are not good sailors would probably rather take the risk of *mal-de-mer* than make the journey in a close atmosphere of a tunnel, and it is further alleged that even if the majority of travellers went by the tunnel the receipts would still be very inadequate. There is, however, the goods traffic, which the Channel Tunnel Company believes would be very important and profitable; as merchandise could be conveyed more quickly, without need of shipping and unshipping.

Our engravings, the smaller of which shows the exterior of the works, and the larger the machinery within the shed, are from sketches by Mr. V. J. Vaillant, of Boulogne-sur-Mer.—*The Graphic.*



THE RAILWAY TUNNEL UNDER THE CHANNEL BETWEEN ENGLAND AND FRANCE.—THE WORKS AT SANGATTE, FRANCE.

ICE SKATING IN SUMMER—THE GLACIARIUM, LONDON.

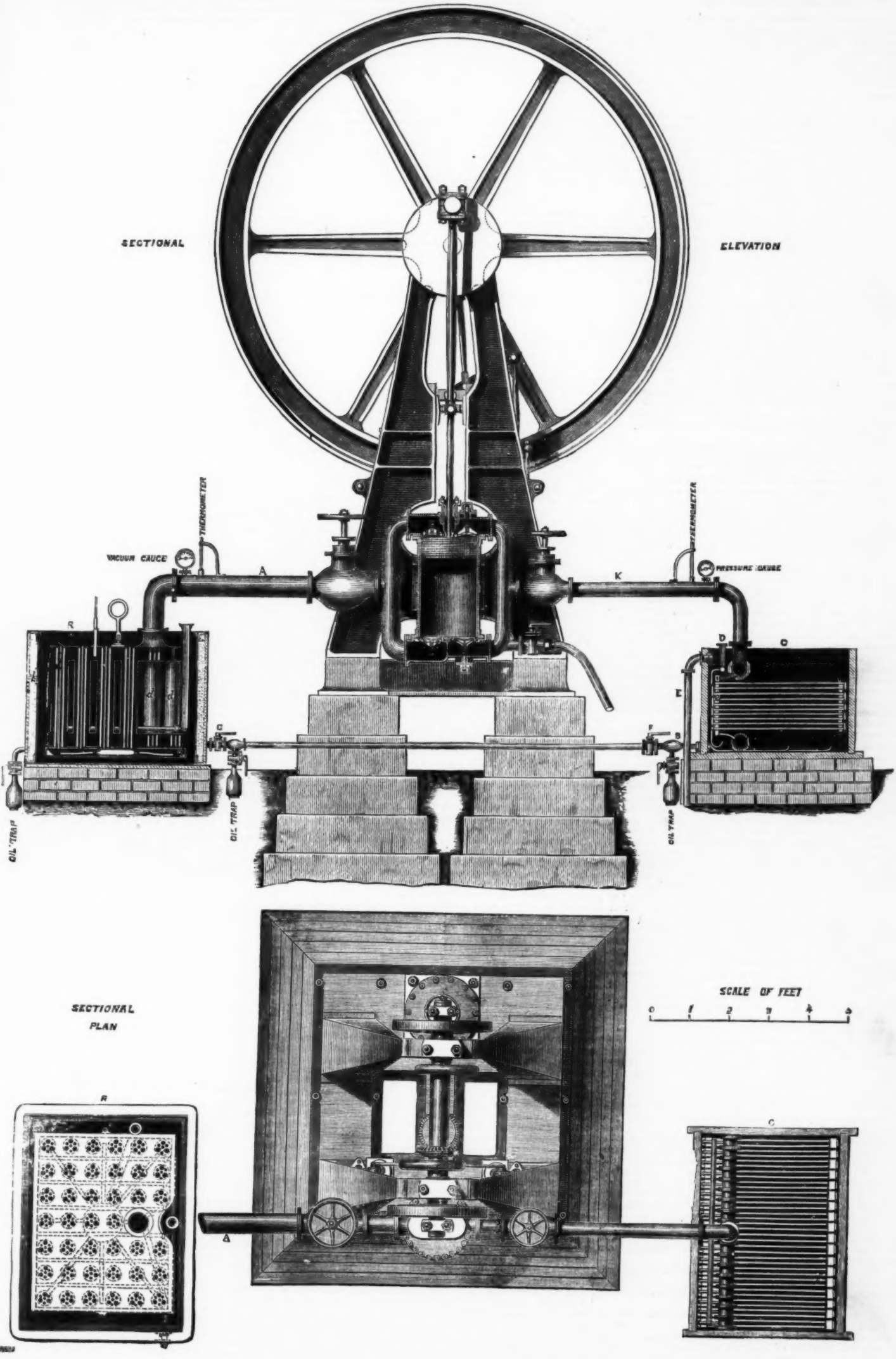
THAT a piece of artificially frozen ice should have been maintained in excellent condition for skating, and have been skated upon for the last four months in London, is a proof of the practical success of an undertaking, which even a sudden collapse would fail to destroy. Upon a small scale and in what may be termed "bulk," the artificial production of ice does not present to the chemist or manufacturer any very great difficulty. But the question assumes a different aspect when the result of artificial congelation is to take the form of an extended surface, in which thickness is enormously disproportionate to the other dimensions. The maintenance, moreover, of this frozen floor, which has also to sustain a considerable amount of pressure at a constant temperature, or, at least, at a temperature sufficiently low to prevent the surface becoming unfit for skating purposes, is not the least arduous part of the operation.

The three essential characteristics of a glaciarium, independently of the mechanical power, are the fluid frozen, the freezing medium, and the freezing agent. The existence of the second of these is rendered necessary by the impracticability of bringing the freezing agent into direct contact with the fluid to be frozen. The first of these in the Chelsea Glaciarium is water, the second a solution of glycerine, and the third sulphurous acid. This last has generally been regarded as a gas, although condensible into a liquid under the pressure of one atmosphere at a temperature of zero Cent. It may be readily prepared on a small scale by heating oil of vitriol with copper clippings, when the following reaction takes place—$2\,(HO\,SO_3) + Cu = SO_2 + Cu\,OSO_3 + 2\,HO$. It has a specific gravity of 2.21, and a hundred cubic inches weigh 63·69 grains. As a liquid, taking water as the standard, its specific gravity is 1.45. For the purposes of the Glaciarium at Chelsea, it is obtained in a liquid state by Mr. Gamgee from Switzerland in strong copper bottles of the shape of a sausage, containing about a couple of hundredweights. At a temperature of 14 deg. Fah. the condensed liquid is in a normal condition, and exerts no pressure. The bottle of acid is placed upon a small truck carrying scales, and a given weight run off into the lower part of the condenser by the pipe B, page 551. The condenser C is filled with water at the ordinary temperature, supplied direct from the main, and has a system of double pipes, inclosing an annular space, well known as "Gamgee's compound tubular arrangement." The smaller, or internal, tubes have a diameter of ⅜ in., and the larger, or external, of 1 in. The water enters at D, passes through the smaller tubes, and arrives at the bottom of the condenser by the pipes curved upwards at the ends, and shown in the drawing. It then rises through the condenser and passes out by the overflow pipe E. The water is continually flowing in this manner, and has therefore a perfect circulation. The sulphurous acid, still in the liquid state, flows out of the bottle into the lower part of the tubes in the condenser. The cock G is then opened, and the liquid acid expands into the gaseous state in the refrigerator R. The cock F is necessary to allow the connection to be cut off between the condenser and the refrigerator if required. Upon entering the refrigerator, the sulphurous acid expands into three hundred times its original volume. The arrangement of the tubes in the refrigerator consists of a number of small tubes inside a larger one *d*, as shown in the drawing. The sulphurous acid, now in the gaseous condition, rises up the large tubes into the upper part of the refrigerator where the tubes are fixed. Every pound weight of sulphurous acid passed through the pipe H absorbs 170 English units of heat.

A double-acting pump of the ordinary construction now comes into operation. A vacuum equal to about 2 in. of mercury is produced, and partly by its means, and partly by its own elastic pressure, the sulphurous acid rises in the pipe A, which is always at a very low temperature, and is then forced through K, which is always at a high temperature, into the condenser C. The gauge shows a pressure of about one and a half atmospheres, which is sufficient with the assistance of the water to effect the recondensation of the gas. When the recondensed liquid—which commences to change its former gaseous state directly it enters the pipe K—enters the condenser it passes into the box into which the double tubes are fitted, and flows through the annular spaces between one half of the tubes as far as the stop *e*. It then passes through the remaining half all together, and finds its way to the bottom of the condenser, and thence back into the refrigerator, thus establishing a perfect circulation. This circulation has been already referred to in the first part of our article. The temperature of the sulphurous acid varies from 21 deg. to 11 deg. Fah. It may be noticed with regard to the pump that the valves were found, when made of the ordinary gun metal, to give out. They have since been made of bright "Bristol brass," with spindles of cast steel screwed and soldered in, and have been found to give complete satisfaction. The sulphurous acid does not in any manner corrode the machinery, and this great advantage is due to the fact that it never comes in contact with the atmosphere.

The freezing medium, which we may now consider, is an aqueous solution of brown glycerine, stored in underground tanks. It has, as will be readily understood, a very low freezing point. A solution of glycerine and water, made in equal proportions, is practically incapable of being frozen. The proportions used at Chelsea are four parts of glycerine to six parts of water, and the mixture freezes at zero Fah. It is first of all pumped into a copper box A fixed in the upper part of the refrigerator R, to be cooled down to the requisite temperature. It runs down the inner tubes of the refrigerator which are fixed in the box, being surrounded by the sulphurous acid which fills the large tubes as already mentioned. It then reaches a cast-iron box at the bottom of the refrigerator, into which it is distributed by a series of radial tubes. Being now sufficiently cooled, it is pumped carefully and without violence into a wooden tank, placed some 10 ft. above the ground, from which it flows by simple gravitation into the main pipes supplying the Glaciarium itself. There are two main pipes connected with the outlet and inlet pipes respectively by junction pipes, one of which is ¾ in. diameter and the other 2 in. The upper pipe is slightly contracted at the junction. The main pipes are circular in section, and have each a diameter of 6 in. They are placed the one vertically over the other at right angles to the small pipes, which are laid longitudinally in the ice floor of the Glaciarium. These small pipes are of copper and oval in section, the major axes being 2½ in. in length and the minor ⅞ in. The space between them varies from ½ in. to ¼ in. They may be said to be laid in pairs, one being connected with the upper main and the other with the lower. The free extremities are connected together by a bent pipe or loop, so that one of the pair acts as a flow and the other as the return pipe. The solution of glycerine flows forwards in every one of these separate pairs, and returns by the other pipe to the outlet pipes, by which it is conducted to the refrigerator, cooled down again, pumped into the elevated tank, to resume once more its course of circulation. During the whole of the circuit the temperature varies to the extent only of a few degrees.

The frozen floor of the Glaciarium presents some points of difference with respect to naturally frozen ice which can not fail to strike the visitor. Being directly supported by concrete, joists, and planking, the ice is of a more solid character, and neither bends nor cracks under the skaters. As it is also frozen at a very low temperature, it is harder than ordinary ice, and possibly may have a higher specific gravity. If we take the thickness of the ice in the Glaciarium at Chelsea, on an average, at 1½ in., the whole floor would represent, *en masse*, a solid block 5 ft. cube.—*The Engineer.*



ICE-MAKING MACHINE AT THE ICE SKATING RINK, LONDON.

LOAN COLLECTION OF SCIENTIFIC INSTRUMENTS.

CHEMISTRY, MINERALOGY, ETC.

Of the treasures of great historical importance exhibited in these sections none will excite more interest than the selection of "home-made" apparatus employed by Dalton in the prosecution of chemical and physical research, and made for the most part with his own hands. They are sent by the Literary and Philosophical Society of Manchester, and comprise barometers, thermometers, with scale graduated by himself, and bearing his initials; tubes for measuring the tension of water, ether, and other liquids, by aid of which "Dalton's Law of Tensions" was deduced; graduated vessels employed for the measurement of gases and the determination of their solubility in water; as well as a number of weights, balances, reagents, and specimens. It need hardly be said that they are all of the simplest kind, and recall to mind the familiar story of the apparatus of Wollaston. No. 49 in the list of the relics of Dalton is a paper containing grain weights made of iron wire; the paper forms part of a note from one of Dalton's pupils (he lived, as is well known, by teaching mathematics at half-a-crown per lesson), in which the writer presents "his compliments to Mr. Dalton, and is sorry that he will not be able to wait upon him to-day, as he is going to Liverpool with a few friends who are trying the railway for the first time." Prof. Roscoe, who has provided the interesting descriptive notice incorporated in the catalogue, also exhibits a portrait of Dalton, copied from a daguerreotype taken from life.

The Edinburgh Museum of Science and Art sends Black's pneumatic trough and a balance, or rather what is more familiarly known as a pair of scales, used by him while professor in the university from 1766 to 1799, and some picturesque chemical vessels in use in the university chemical laboratory during the latter half of the last century.

The Royal Institution, as might be expected, has a wealth of treasures to contribute. First among them we find the balance used by Cavendish, remarkable for its great height, there being a distance of more than two feet between the end of the beam and the pans; it was designed by Cavendish and made by Harrison, and at the death of the great philosopher was presented to Davy.

The next balance, one with a very ponderous beam and pans, and with an index-needle placed at the end of the beam, was used by Young, Davy, and Faraday. While on the subject of balances—to which we shall, however, have cause to recur—attention should be directed to another and a modern instrument placed in this room (Section XVII.), specially made by Oertling of London for Messrs. Lawes and Gilbert, and used by them for the determination of the amount of water given off by plants during their growth; it is constructed to turn with less than one grain when loaded with 50 lbs., or even more.

The Royal Institution likewise sends the batteries used by Davy for the decomposition of the alkalies, and along with them his note-book, laid open at the page dated October 19, 1807, where he describes the decomposition of potash.

Other batteries of historical interest, such as that of Daniell, and the gas-battery of Grove, are in Section X. (*Electricity*) in the lower gallery. Perhaps, however, of all the treasures sent from Albemarle Street the relics of Faraday will prove most attractive, in that they bear, like Dalton's apparatus, actual evidence of the hand of the master who fashioned them. We have the apparatus which he employed for the condensation and liquefaction of gases, and the original tubes containing eleven gases in a liquefied state, as well as the note-book in which he records his labors in a field which under his hands yielded such rich results.

We pass on to find some masses of metal, "pieces of rhodium extracted from platinum ore," together with some platinum apparatus, which are exhibited close by, and which were, it is presumed, once the property of Wollaston.

The latest phase of an important branch of industry which owes so much to the labors of Wollaston, the working of platinum, is admirably illustrated by Messrs. Johnson and Mathey, who show the Deville furnace containing platinum which has been fused, as well as ingots of that metal, weighing 75 kilog., which had been melted in it within the space of an hour. Other specimens of metals of considerable rarity and no slight interest will be passed over through want of proper labels; we allude to specimens of calcium, barium and strontium, exhibited among a host of other chemicals by Messrs. Hopkins and Williams. These are to be regarded as historical specimens, having been prepared twenty years ago by the lamented Matthiessen by modifications of the processes devised by Bunsen.

Our necessarily incomplete survey has led us down to comparatively recent years, from which date the water vacuum pump of Dr. Sprengel—catalogued, but for some unaccountable reason not exhibited (for a specimen of his mercury pump see Section V., *Molecular Physics*)—the apparatus for the investigation of ozone, designed respectively by M. Soret, Sir B. Brodie, and Dr. Andrews, that employed by Professor A. Mitscherlich for elementary organic analysis by the aid of mercury oxide, and many more. Most of the recent chemical apparatus is transferred to Section XIX. (*Educational Appliances*), where the quantity is found to be little short of bewildering. Under 4105, 4112, and 4500, for example, three different philosophical-instrument makers of Berlin exhibit specimens of the same apparatus for the electrolysis of water, hydrochloric acid and ammonia.

The magnificent suite of compounds illustrating Professor Frankland's researches on the isolation of the organic radicals and the synthesis of the acids of the acetic, lactic, and acrylic series, etc.; the specimens illustrative of Mr. Perkins's investigations, and Mr. Schorlemmer's inquiry into the constitution of the hydrocarbons of Pennsylvania petroleum and of aurin and its derivatives will prove of the greatest interest to the student of organic chemistry; while Professor Roscoe's splendid collection of vanadium compounds ably represents recent progress in inorganic chemistry, and applied science finds a brilliant illustration in the collection of aniline products displayed by Messrs. Brooke, Simpson, and Spiller.

To practically demonstrate his process for the partial recovery of poisons after they have been administered in fatal doses, Professor Sokoloff, of St. Petersburg, shows glass tubes containing:

1. 0.057 gramme prussic acid, of which 0.051 gramme was recovered after sixty days.

2. 0.500 gramme coniine, of which 0.125 gramme was recovered after forty-five days.

3. 0.300 gramme nicotine, of which 0.076 gramme was recovered after twenty days.

The chief historical apparatus in Section XVII. are the original blowpipe of Plattner, and Harkort's self-made scale for the measurement of the diameter of minute spherules of silver, both lent by the Royal Mining Academy of Freiberg; the contact goniometer used by the Abbé Haüy, sent by the University of Oxford; Charles's original goniometer, deposited by the Conservatoire des Arts et Métiers, and the Wollaston goniometer which belonged to the late Dr. Whewell. Lingke & Co., of Freiberg, exhibit a complete set of blowpipe apparatus, as devised by Plattner, the portable balance being beautifully finished.

Dr. Richter, the director of the Freiberg Academy, displays some very beautiful illustrations, apparently in water-color, of metallic incrustations produced on charcoal by aid of the blowpipe flame. The films are depicted on a black ground, and we would especially draw attention to the remarkably faithful representations of *Schwefelblei, Zinkoxyd, Tellur, Zink und Cadmium, Molybdän*, and *Silber und Antimon*. (Compare with similar films on aluminium plates exhibited by Major Ross in another part of the gallery.) Several typical teaching-collections of rocks and minerals are shown in this section, but no specimen of great rarity or historic interest, and they might find a place with other educational appliances. Sections of rocks, and drawings of such sections, are shown in great number: among them may be mentioned the plates prepared by the indefatigable Dr. Möhl, of Cassel, and the colored drawings of sections of diabase, diorite, etc., by M. Stürtz, of Bonn.

The Rev. N. Brady exhibits a number of models of crystals and a series of twelve beautifully finished water-color drawings, illustrating the optical phenomena displayed, in polarized light, by sections of minerals cut perpendicular to the optic axis, or axes of the crystals.—*Academy*.

THE INDUSTRIAL USES OF ALUMINIUM.

It is now about twenty years since the celebrated French chemist, Deville, succeeded in demonstrating the possibility of producing the metal aluminium upon the large scale; but up to the present the extent to which this interesting and praiseworthy invention has been utilized has but to a slight degree realized the sanguine expectations which intelligent minds of all professions have been accustomed to associate with it. So important, indeed, were the fruits of Deville's first investigation deemed to be that they were at once invested with the dignity of royal patronage, and the first works for the manufacture of the new metal were shortly thereafter erected at Javelle, near Paris, from the private purse of the late Emperor of the French. It was expected that the new product would at once find its way into the useful arts as an effective and valuable substitute for many other metals. That these expectations were well founded will be apparent from the characteristic and very exceptional properties of the metal. A bright pure surface of aluminium possesses a grayish-white color, something between that of zinc and tin. Its extreme lightness is one of its very distinguishing properties, and affords an immediate means of identifying it from every other metal. Its specific gravity is but 2.5 (water = 1), from which it appears that it is about three times lighter than copper, four times lighter than silver, and nearly eight times lighter than gold. When struck it emits a loud, clear, musical tone, which has been compared with that of crystal glass. The keen observing powers of the French chemist did not permit this property to pass unnoticed. He suggested the employment of aluminium for bell metal, and in the year 1868 presented to the Royal Institution of Great Britain a bell 1½ ft. in diameter, which proved to possess a most exquisite tone, and which, despite its not inconsiderable dimension, weighed no more than 44 lbs.

The metal may be hammered out into the thinnest leaves, rolled into plates or sheets, and drawn into the finest wire. Its hardness approaches that of fine silver, and its tensile strength equals that of copper. Its melting point lies at 700° C. (about 1300° F.) or between that of zinc and silver; and it is worthy of note that it fuses with extreme slowness, and does not vaporize even in the heat of the blast furnace. Generally speaking, the metal is workable to an extraordinary degree, and it may be filed, turned, pressed, engraved, and coined quite readily. In compact masses the metal is quite indifferent to atmospheric influences, and even when being smelted it does not sensibly oxidize. It must be remarked, however, that the properties above enumerated are predicated upon the presumption that the metal is free from impurities.

In the manufacture of jewelry and other articles of luxury it is probable that aluminium may in time play an important part, though it is scarcely possible for it to ever rival the popularity of silver in these uses. In Paris, which, by the way, has always remained the head-quarters of the aluminium industry, it appears to be employed to a considerable extent for elegant inlaid work upon jewel and dressing cases, fans, etc., for lids and covers of glasses, and for a variety of small articles of *galanterie*. From what has been done in this direction, we can estimate its fitness for a thousand elegant articles of taste, fancy, and utility, when once its popularity is established before the world at large, which is now scarcely cognizant of the existence of such a metal as aluminium. The clock and watch-makers' art, the manufacturers of surgical and musical instruments, and of artificial teeth, and especially the manufacturers of fancy articles, such as seals, pen-holders, paper-weights, smokers' and sportsmen's necessaries, shirt and sleeve-buttons, canes and riding-whips, harness decorations, statuettes, gas-fixtures and lamps, and of other articles too numerous to mention, would, without doubt, derive much advantage and profit from the employment of aluminium; and, sooner or later, its peculiar fitness for these uses will be recognized.

For the manufacture of philosophical and engineering instruments, and especially the latter, the indifference of aluminium to atmospheric influences, and its extreme lightness, have of late met with general recognition, and the employment of the metal for these uses is steadily growing in favor.

For household utensils, likewise, aluminium has been highly recommended; but, though for this purpose, as for others, neither its want of desirable properties nor excessive costliness have stood in the way of its introduction, it has been opposed by the despotic rule of custom or fashion, and in no instance with less show of reason. How much, for example, has been written and spoken concerning the danger of poisoning from the vessels employed in preparing food? How many warnings have been uttered against using copper cooking utensils, pots with lead glazing, and silver spoons that form verdigris? Were these household goods made of aluminium we should be in possession of vessels that, so far as outward appearance and durability go, leave very little to be desired; that, furthermore, would be far more convenient to handle than the customary wares they would replace; and, what is of perhaps more importance, that would be perfectly innocuous. It appears somewhat curious that the experiment has never been tried of introducing the use of aluminium spoons. The present or prospective cost of aluminium can scarcely be offered as an objection thereto, for this is now only about one half that of silver, while the difference in the specific gravity of the two metals is so considerable that for the money value of one silver spoon of good quality one might obtain no less than seven spoons of aluminium of equal size and strength. That prejudice and fashion are to some extent to blame for the general want of appreciation—and even of total ignorance—of the eminently fitting characteristics of the new metal for a variety of uses is very manifest, and the clearing away of such obstacles is generally a matter of great difficulty.

The alloys of aluminium are, however, worthy of special consideration, and there is a reasonable probability that a wide field of utility may be open for them in the future. Dr. Biedermann, referring to this subject, remarks: "Although there is no mistaking the fact that the high expectations with which the appearance of aluminium filled the public mind have not been fulfilled, yet the aluminium industry has a safe guarantee of its existence in the use of the metal for aluminium alloys, which are capable of the most extensive use on account of their excellent qualities." The only aluminium alloys which have, however, acquired importance in the arts are the so-called aluminium bronzes.

According to M. Morin, the director of the manufactory at Nanterre, very homogeneous alloys are obtained with copper and 5, 7½, and 10 per cent of aluminium. The alloys with 5 and 10 per cent of aluminium are both of a golden color, while that with 7½ per cent has a greenish tint. Even so small an addition as 1 per cent of aluminium to copper, according to another authority, considerably increases its ductility and fusibility, and imparts to it the property of completely filling the mould, making a dense casting free from all air bubbles. At the same time the copper becomes more resistant of chemical reagents, increases in hardness without losing in malleability, and unites in itself the most valuable qualities of bronze and brass. A copper alloy with 2 per cent of aluminium is said to be used in the studio of Christofle, in Paris, for works of art. It works well under the chisel and graver.

The true aluminium bronzes, according to Rudolph Wagner, were first made by John Percy, in 1856. As above referred to, they are alloys containing 90 to 95 per cent of copper with 10 to 5 per cent of aluminium. The direct mixture, by first fusion, of 10 parts of aluminium and 90 of copper, gives a brittle alloy, which, however, increases in strength and tenacity by several successive fusions. At each operation a little aluminium is lost. After the compound has been melted three or four times, however, the proportion of aluminium does not appear to change, and the alloy may again be re-melted several times without alteration. These fusions are effected in crucibles. The aluminium bronze is homogeneous, and possesses sufficient expansion to fill the remotest parts of the mould. It affords sharp castings that can be worked more readily than steel. Aluminium bronze may be forged at a dull-red heat, and hammered until cooled off without presenting any flaws or cracks. Like copper, it is rendered milder and more ductile by being plunged into cold water when hot. The bronze polishes beautifully and possesses great strength—according to Anderson's experiments an average of 75,618½ lbs. per square inch. The resistance to compression is feeble. From the experiments of Col. Strange on the relative rigidity of brass, ordinary, and aluminium bronze, it appears that the last named is 40 times as rigid as brass, and 3 times as rigid as ordinary bronze.

Other experiments have shown that aluminium bronze does not expand or contract as much as ordinary bronze, or brass; that under the tool it produces long and resisting chips, does not clog the file, engraves nicely, etc., and it is easily rolled into sheets; that in the melted state it expands very much, and is fit for the sharpest castings; but that, as it cools off rapidly, it is subject to shrinkage, and hence to cracks when the articles are bulky, hence requiring numerous runners and a heavy feeding head; and lastly, that although not entirely unoxidizable, it is not so readily tarnished by contact with the air as polished brass, iron, steel, etc. Dr. Biedermann speaks very highly of this metal. "In the construction of physical, geodic, and astronomical instruments," he says, "it is far preferable to all other metals. In jewelry, and articles of art and luxury, it is employed in large quantities. Many kinds of house utensils are made of it, and it is also adapted to journal and axle boxes. Gun and pistol barrels, as well as rifled cannon, have been made of it, and have done excellent service." It has been highly recommended for type metal; type made of it lasting, it is affirmed, fully 50 times as long as those from common metal type. It has been employed for the bed of perforating machines for perforating postage-stamps, and for the mainsprings of watches (90 copper and 5 aluminium), being very hard and elastic, not magnetic, and less liable to rust than steel. Its price, however, ranging as it does from $3 to $10 per lb., according to its percentage of aluminium, is probably the greatest impediment to its common use.

Aluminium alloys with many other metals have been made—notably with silver and iron; but none of them have acquired a permanent value in the arts. They may be passed over with the brief remark that aluminium containing 4 per cent of silver is employed for the beams of fine balances, for which it is peculiarly fitted from its comparative lightness and stability; and that the addition of a small percentage of aluminium to steel is claimed to impart special virtues to the latter—a claim which, however, has not yet been well established.

In another direction—in electro-plating and coating other metals with aluminium—numerous experiments have been tried, but thus far without practical result.

A few words more concerning the process of manufacture and the present commercial importance of the metal, and we have done. Its metallurgical production is as follows:—

Aluminium is manufactured by decomposing the double chloride of aluminium and sodium, with the aid of metallic sodium. The sodium (which, by the way, has been materially cheapened in price since the establishment of the aluminium industry) is obtained by heating to redness a mixture of 100 parts of calcined soda, 15 parts of chalk, and 45 parts of coal. The chloride of aluminium is prepared by passing chlorine gas over a moderately heated mixture of pure alumina (obtained either from alum or the mineral bauxite), common salt, and coal tar. This operation is conducted in an iron gas retort, and the result of the interaction of the several substances present is the combination of the coal tar with the oxygen of the alumina, and the production of aluminium chloride, which unites with the chloride of sodium (common salt), forming a double salt, which volatilizes and is passed off into a separate chamber, where it condenses. From this method of obtaining the chloride, it is impossible to keep it free from chloride of iron, for which reason the Parisian aluminium is invariably impurified therewith. From this double chloride of aluminium and sodium the metallic aluminium is obtained, either by passing it in the form of vapor over a heated surface of metallic sodium, in a simply constructed and connected system of iron cylinders appropriately heated; or the materials are at once mixed and heated.

Rose, of Berlin, instead of the artificially prepared aluminium chloride, employed the mineral kryolite (a natural compound occurring in deposits of considerable magnitude in Greenland, and consisting of fluoride of aluminium and

sodium) quite successfully. By heating this mineral with sodium, metallic aluminium and fluoride of sodium are produced, and the latter compound is gotten rid of by treating the resulting mass with caustic lime. Of late the metal has also been manufactured from the mineral bauxite.

At present there are four aluminium works in existence, of which three are in France and one in England. Their total production amounts to about 3500 lbs. yearly, of which 2000 lbs. are produced in France and 1500 lbs. in England. Its market value has averaged about $15 per lb., and has been for some years stationary at that figure.—*Polytechnic Review.*

ROSCOELITE, A VANADIUM MICA.

By JAMES BLAKE, M.D.

THE mineral, to which I have given the name of Roscoelite—in honor of Professor Roscoe, of Manchester, who has done so much for the chemical history of vanadium—is a well marked species of mica, containing quite a large percentage of vanadium. It was found in a gold mine at Granite Creek, El Dorado County, in the lower hills on the western slope of the Sierra Nevada. It occurs in the hanging wall of a small quartz vein, the country rock being porphyry. The mica appears to have been principally deposited in fissures in the prophyry, and is usually found in layers from a tenth to half an inch thick, and seldom extending continuously for more than two or three inches. It is also found filling cavities in the quartz. The crystals are quite brilliant, of a dark-green color, seldom more than 0.1 inch long, and, when occurring in fissures, form two series starting from each side of the fissure and meeting in the centre. They are also found in nodules with a stellar arrangement, more particularly in the cavities of the quartz. They are strongly doubly refracting. Sp. gr. 2.33. They weather into a light yellow wacke. The whole thickness of the vein-matter in which the mica is found is not more than a few inches. The mine in which it occurs has been worked for gold, and it is in these micaceous deposits that the greater part of the gold is found. Some portions are extremely rich, as much as $240 having been washed out from a single panful; and while at the mine I saw $40 taken from a few handfuls. The gold is commonly found in the form of fine scales which have been deposited between the crystals of the mica. So generally is it diffused that it is impossible to find a piece of the mica as large as a bean that does not contain gold. The mine is worked by means of an open cut, now about 30 feet deep and 150 feet long.

The most interesting fact connected with this mineral is the large proportion of vanadium it contains, and that, too, in a form in which it has not before been found, unless the small traces of it detected in some basalts should be part of an analogous compound.

Dr. F. A. Genth says: I am indebted to Dr. James Blake, of San Francisco, California, for a small quantity of the very interesting mineral, which he called "Roscoelite," in honor of Professor Roscoe, whose important investigations have put vanadium in its proper place among the elements.

Roscoelite occurs in small seams, varying in thickness from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in a decomposed yellowish, brownish, or greenish rock. These seams are made up of small micaceous scales, sometimes $\frac{1}{4}$ of an inch in length, mostly smaller and frequently arranged in stellate or fan-shaped groups. They show an eminent basal cleavage. Soft. The specific gravity of the purest scales (showing less than one per cent of impurities) was found to be 2.938; another specimen of less purity gave 2.921. Lustre pearly, inclining to submetallic. Color dark clove-brown to greenish-brown, sometimes dark brownish-green.

Before the blowpipe it fuses easily to a black glass, coloring the flame slightly pink. With salt of phosphorus gives a skeleton of silicic acid, a dark yellow bead in the oxidizing flame, and an emerald-green bead in the reducing flame. Only slightly acted upon by acids, even by boiling concentrated sulphuric acid; but readily decomposed by dilute sulphuric acid, when heated in a sealed tube at a temperature of about 180° C., leaving the silicic acid in the form of white pearly scales, and yielding a deep bluish-green solution. With sodic carbonate it fuses to a white mass. The roscoelite which I received for investigation was so much mixed with other substances, such as gold, quartz, a feldspathic mineral, a dark mineral and very minute quantities of one of orange color, that it was impossible to select for analysis material of perfect purity.—*American Journal of Science and Arts.*

PROCESS FOR PHOTOCHROMIC PRINTS.

By LEON VIDAL, Marseilles, France.

CONSISTS in producing upon gelatine films, in a manner similar or analogous to the production of carbon pictures, a series of partial pictures in the color appropriate to the portion of the finished picture which such partial picture is to represent, and afterward mounting said partial pictures, one over the other in proper order, on a suitable supporting-surface, the partial pictures being properly registered, so as to fall in the proper relative positions in the finished picture.

I produce a series of negatives equal in number to the colors to be represented in the finished picture, and carefully stop out all portions of the same, with any opaque coloring matter, that are to be left without color in the partial picture to be produced from such negative. Say, for instance, that the partial picture to be thus produced is to represent the yellow portions of the finished pictures, the portions of the negative representing all the other parts of the finished picture are stopped out, and a partial picture is produced upon a gelatine film prepared with a yellow-body color, similar to the production of the ordinary carbon pictures. Upon the development of the picture a partial picture, with properly-graduated lights and shades, will be left upon the gelatine film in monochrome or a single color, which, in the instance just illustrated, would be yellow. The prepared gelatine film, during the production of the picture, must be secured upon a proper supporting-surface, which may consist of a glass or other suitably prepared sheet of paper, or plate of metal or glass, and after the production of the picture the film is removed by washing it off. The portions of the gelatine film not acted upon by the light will remain transparent or translucent, so that the colors, when the films are arranged in proper order, will show through such portions. The remaining partial pictures are prepared in the same manner, and when the full number is produced, they are removed from their supporting-plates and mounted in proper order, one upon another, until the whole picture is completed.

The various partial pictures thus formed are marked by the action of the light, so as to properly register, by means of suitable marks on the original negatives, and, previous to mounting them one upon the other, are cleansed from the greasy material by washing in benzine.

It is evident that the ground portions of the picture may be produced by mechanical means, such as chromo-lithography or otherwise, and combine with a series of partial pictures prepared as above described, and that the partial pictures may be mounted upon a transparent medium, or simply combined without mounting upon any supporting material, so as to serve as polychromic transparencies, to be viewed by transmitted light.

VOLATILITY OF BARIUM, STRONTIUM, AND CALCIUM.

By Prof. J. W. MALLET.

THE author has ascertained, by a series of carefully made experiments, that when lime, baryta, or strontia are heated in contact with metallic aluminium to a very high temperature in a carbon crucible, it suffers an appreciable loss of weight, in some instances to the extent of more than 3 per cent, indicating that the alkaline earth must have been partly reduced and the metal volatilized. This supposition is confirmed by the observation of the flame of the carbon monoxide which is given off, the characteristic lines of the metals being distinctly visible when it is examined with the spectroscope.

DYEING RECIPES.

From Reimann.

BLACK ON WOOLLEN KNITTING YARNS (55 lbs.).

Boil for forty-five minutes with 30½ ozs. chromate of potash, 3½ ozs. blue stone, the same weight of argol, and 7 oz. sulphuric acid. Take through water, and dye at a boil for three-quarters of an hour with 33 lbs. logwood.

VIOLET ON WOOLLEN YARNS (11 lbs.).

Dye with methyl violet, adding 8¼ ozs. prepared tartar. The use of this latter ingredient prevents smearing.

BROWN ON WOOLLEN YARN (55 lbs.).

Boil for three-quarters of an hour with 30 ozs. chromate of potash. Take through water the day after, and dye with 26½ lbs. peachwood and 2 lbs. 3 ozs. fustic. Lighter or darker shades can be obtained by boiling for a shorter or longer time. For very pale shades, 3½ ozs. sulphate of alumina may be added to the beck; and for very dark shades, sadden with logwood.

BLACK ON WOOLLEN PIECE GOODS (110 lbs).

Boil for ninety minutes with 8¼ lbs. copperas, 4 lbs. 6 ozs. blue stone, the same weight of argol, and 11 lbs. fustic. Dye afterwards with 44 lbs. logwood.

DEEP BLUE ON WOOLLEN PIECE GOODS (110 lbs.).

Boil for an hour with 5 lbs. 7 ozs. alum, 2¾ lbs. argol, 17½ ozs. chromate of potash, and 3½ lbs. perchloride of tin. Let cool in the liquor, and then dye at a boil for one hour, with 22 lbs. logwood and 11 lbs. extract of indigo.

BISMARCK BROWN ON FELT HATS (50).

Prepare with soda as formerly directed, and boil for forty-five minutes with 22 lbs. fustic, 10½ ozs. logwood, 3½ lbs. sumach, 8¼ lbs. sanders, and 17½ ozs. argol. Boil for two hours, and add two lbs. 3 ozs. blue stone and 7 ozs. copperas. Re-enter the hats, and boil for three-quarters of an hour longer.

BROWN ON MIXED HATS (5 dozen).

Prepare with soda, and boil for 2 hours with 22 lbs. fustic, 5 lbs. 7 ozs. madder, 25¾ ozs. turmeric, 2 lbs. 3 ozs. madder, 25¾ ozs. sanders, and 17½ ozs. argol. Air the hats, and add 17½ fluid ozs. black liquor and 2½ ozs. copperas. Re-enter the hats and boil again for an hour.

CHROME BROWN ON FELT HATS (50 hats).

Prepare with 4¾ ozs. chromate of potash, 14 ozs. argol, and 17½ fluid ozs. solution of tin. Let the hats lie over night in the flat, and dye the next morning in a fresh water with—

17½ ozs. young fustic,
26 " fustic,
17½ " turmeric,
6 lbs. 9 ozs. madder,
3 " 4 " peachwood,
7 ozs. logwood.

BLACK ON LEATHER.

Dissolve 1¾ oz. solid logwood extract and ¾ oz. solid fustic extract in boiling water, and make up to 35 fluid ozs. The leather, which must have been previously cleaned and stretched out, is brushed over five times at 100° Fahr.; 155 grs. of chromate of potash and 77 grs. blue stone are then dissolved in the same quantity of water; the leather is brushed twice with the solution, and then again with the decoction of logwood; 150 grs. of liquid ammonia are then poured into 35 fluid ozs. of water, and the leather is gone over with that. To make the leather supple, stir up 150 grs. yolk of egg in 75 grs. of glycerine, make it up with water to 35 fluid ozs., and rub the leather with it. Let it get half dry, and rub with a clean woollen rag.

BROWN ON LEATHER.

Dissolve 75 grains of tannin in 35 fluid ounces of Bismarck, and brush the stretched leather. Dissolve 75 grains of Bismarck brown and 45 grains of white glue in 35 fluid ounces of water, and brush at 100° Fahr. If a darker shade is desired, brush over with a solution of 15 to 45 grains of methyl violet in 35 fluid ounces of water, and let dry. Finish with yolk of egg as above.

YELLOW ON LEATHER.

Brush over with a solution of soda at ½° Baume, dry and brush over with nitrate of iron at the same strength; repeat, if not dark enough. Finish with yolk of egg.
(This will be a buff rather than a yellow.)

BLUE ON LEATHER.

Extract 155 grains of gall-nuts in 35 fluid ounces of water, and brush over. Dissolve 155 grains of soluble aniline blue and 75 grains of glue in 35 fluid ounces of water. Brush over three times; dry, and finish with yolk of egg.

GREEN ON LEATHER.

Extract ¾ ounce of gall-nuts in 35 fluid ounces of water, and brush over the leather three times; dissolve 155 grains extract of indigo and the same weight of alum in 35 fluid ounces of water, and brush over and dry with the cold solution. Dissolve 155 grains extract of fustic in the same quantity of water, and brush twice. Dissolve 77 grains of glue in the same quantity of water; dry, and finish with yolk of egg as above.

LILAC ON LEATHER.

Dissolve 155 grains of tannin in 35 ounces of water, and brush. Then dissolve 77,155, or 310 grains of methyl violet according to shade, in 35 fluid ounces of water and brush over thrice. Dissolve 155 grains of glue and the same weight of glycerine in 35 fluid ounces of water; brush and dry.

MODE ON LEATHER.

Extract 45 grains of logwood in 35 fluid ounces of water, and dissolve it in 30 grains of orchil. Brush the leather with the solution at 110° Fahr. Next dissolve 30 grains copperas in 35 fluic ounces of water; brush with the solution, and then brush with water. If a reddish tint is desired dissolve along with the copperas 30 grains of alum. When dry rub the leather with a woollen rag and rye-meal.

GRAY ON LEATHER.

Dissolve 155 grains of tannin in 35 fluid ounces of water, and brush. Dissolve 30 grains of copperas in 35 fluid ounces of water and brush. If not dark enough, repeat. Dry and rub with rye-meal.

Green (for 20 garments)—

The goods previously well cleansed are boiled for two hours with 3½ lbs. alum, 17½ ozs. turmeric, and extract of indigo as requisite. After this press and wash. Dissolve in a cold water 8¾ ozs. tannin, and add the decoction of 17½ ozs. turmeric. Stir well, enter the goods, which must be spread out; turn several times, and steep for two hours. Lift and add 4½ ozs. oil of vitriol. Stir well, enter again, give five turns, and take out and rinse again. Make up a fresh beck with 3½ to 5½ ozs. methyl green. Enter the goods cold, and work till the beck is exhausted. Take out and dry.

This gives a light shade; for medium and dark greens add to the methyl-green beck the solution of 30 grs. methyl violet of the bluest shade.

Copperas is to be avoided in darkening greens or mixed goods; it never gives a bright shade. Picric acid is also to be avoided; in wool dyeing it is of very little use, as it is mostly removed by subsequent operations. In dyeing cotton with methyl green it is simply injurious.

FAST AND BRIGHT BROWN (220 lbs. woollen cloth).

Take 6½ lbs. of argol, fustic, sanders, madder, logwood, and sumach to shade. Boil for 1½ hour, and sadden with blue stone, and lastly with copperas. For a brighter shade to the same weight of goods take 5½ lbs. chromate of potash, 3½ lbs. each of argol and sulphuric acid; boil for two hours, and dye with fustic, sanders, madder, and logwood, and sadden with copperas.

PRINTING HALF SILKS.

Blue (350 fluid ounces)—

17½ ozs. gum tragacanth,
4½ ozs. white glue

are boiled together, and in the liquid are dissolved

1½ oz. soluble blue.

Boil up again, let cool and print; hang up and steam.

Yellow (350 fluid ounces)—

Boil up 1½ oz. berry liquor at 5° B., with 17½ ozs. gum tragacanth. Stir till cold and add

3½ ozs. tin salt,
8¾ ozs. oxalic acid.

The addition of a little extract of cochineal gives an orange shade.

Black (350 fluid ounces)—

2 lbs. 3 ozs. solid French extract of logwood,
4½ ozs. solid French extract of fustic, and
13 ozs. gum tragacanth.

Dissolve in water, boil up, let cool, and stir in

17½ ozs. nitrate of iron at 30° B., and
2 lbs. 3 ozs. acetate of iron at 7° B.

Stir up again, print, hang up for twenty-four hours, and steam strongly.

GOLDEN BROWN ON CLOTH (110 lbs.).

Boil out 88 lbs. fustic, and add to the decoction 27 lbs. calliatura wood, 8¾ lbs. turmeric, and 5½ lbs. argol. Boil for an hour, take out, add 5½ lbs. blue stone, boil half an hour, take out again, and sadden with 5½ ozs. copperas.

CHAMOIS ON CLOTH (110 lbs.).

Add to a water 22 lbs. alum, 13 lbs. 2 ozs. alum, 4 lbs. 6 ozs. perchloride of tin; boil up, skim, and add from 5½ to 7 ozs. cochineal, and dye to shade at a boil.

ORANGE ON CLOTH (110 lbs.).

Boil up in the beck 26 ozs. perchloride of tin; add 5 lbs. oxalic acid, 3½ lbs. tin crystals, 17½ ozs. flavin, and from 7 to 17 ozs. cochineal. Boil up, cool, enter, and boil for three-quarters of an hour.

GOLDEN OLIVE ON CLOTH (110 lbs.).

Boil together the decoction of 88 lbs. fustic, 22 lbs. turmeric, 2¼ lbs. orchil, 11 lbs. alum, and 4 lbs. 6 ozs. argol. Cool, enter, and boil for one hour.

BILLIARD GREEN ON CLOTH (110 lbs.).

Dissolve in a water 16 lbs. 6 ozs. alum, boil in it 22 lbs. fustic, and add 5 lbs. 7 ozs. extract of indigo.

DRAB ON CLOTH (110 lbs.).

3½ lbs. sumach, 6 lbs. 9 ozs. madder, and the decoction of 3½ ozs. sanders, and 6½ ozs. fustic. Boil up together, add 3½ ozs. argol; cool, enter, boil for an hour and sadden with 1¾ oz. copperas.

TOPPED BLUE ON COTTON AND LINEN YARNS (11 lbs.).

First method.—Give a light blue in the vat, sour, rinse, and add to a cold water 1 oz. tin crystals, and 3 lbs. 6 ozs. nitrate of iron. Work for two hours, take out, make up a fresh cold beck with 2¾ to 3½ lbs. logwood, and 17 ozs. alum; dye cold in this for a quarter of an hour, and rinse. If the color is not to smear, take through a lukewarm decoction of 4½ ozs. glue, and dry.

Second method.—Vat as before, and make up a beck with so-called indigo substitute (a mixture of indulin and extract of logwood), enter the yarn, work for thirty minutes, at 144° Fahr., and sadden in a fresh beck with 1½ ozs. chromate of potash and ¾ oz. blue stone. This is a very dark shade.

Third method.—Vat as before, and work for an hour in a beck of 11 lbs. logwood, and 17½ ozs. alum. Make up a fresh cold beck with 2 lbs. 3 ozs. copperas. Give ten turns in this, and according to shade give two or three dips in both becks. If not deep enough, add a little nitrate of iron to the logwood beck. Rinse, and take through glue.

THE WORLD'S ALPHABETS.

THE alphabet which we use appears to have been derived from the Greek alphabet, and the latter is merely a transformation of the ancient hieroglyphics of Egypt and Assyria. It is an imperfect one, however, since it fails in signs for combined sounds, which must therefore be represented by combinations of letters. Still it is the best of its kind, and the Japanese are adopting it in preference to their own con-

FIG. 1.—ASSYRIAN CUNEIFORM INSCRIPTION.

fused system of letters. The Germans, with like predilection, also show a tendency to disuse the less legible alphabet devised by Bishop Ulfilas in the fourth century; and the Russians likewise are inclined to abandon the alphabet which they alone have hitherto employed.

The Hebrew, Arab, and Sanscrit alphabets are derived from the Phœnician, which became, through the voyages of Phœnician sailors, known throughout the ancient world. Semitic; but under the influence of the Chinese the mode of writing the characters transverse the page was changed to the vertical system. The present Japanese alphabet is merely a compound of Chinese signs arranged in an alphabetic sense. The Chinese writing itself is but a mixture of alphabetic and ideographic, which it is almost impossible for a

FIG. 2.—EGYPTIAN HIEROGLYPHICS.

foreigner completely to master. Previous to the Spanish conquest the civilized people of Central America had a hieroglyphic system; but no one has ever interpreted it, although there are abundant remains.

The engravings herewith presented (extracted from *La Nature*) display all the modes of writing employed by man ever since he learned thus to express ideas. Fig. 1 is a specimen of the Assyrian cuneiform inscription on the Tak-Kesra Stone, now in the French National Library. This is an oval rebuses—than alphabetic. In Fig. 4 the phrase "How we hear each other speaking the language peculiar to the country where we were born" is rendered first in the French language in our alphabet, then into German, ancient Greek, modern Russ, Irish, Sanscrit, Hindoo, Canarese, Tamul,

FIG. 3.—CENTRAL AMERICAN HIEROGLYPHICS.

modern Armenian, Syro-Chaldaic, Persian, Coptic, and Amharic. It is easy to see that all relate to two or three original

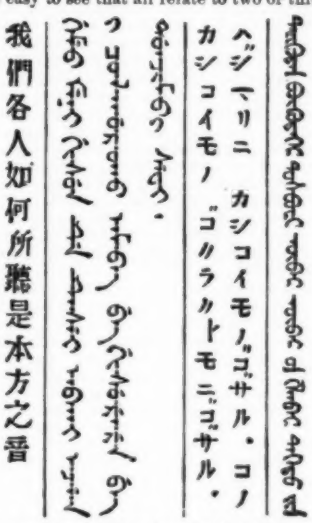


FIG. 5.—ASIATIC ALPHABETS.

types which have undergone modifications according to locality. Lastly in Fig. 5 are represented in parallel lines the same phrase in Chinese, Manchu, Japanese, and Kalmuck.

Comment donc chacun de nous les entendons-nous parler la propre langue du pays où nous sommes nés?

Français.

Wie hören wir denn ein jeglicher seine Sprache, darinnen wir geboren sind?

Allemand.

Καὶ πῶς ἡμεῖς ἀκούομεν ἕκαστος τῇ ἰδίᾳ διαλέκτῳ ἡμῶν ἐν ᾗ ἐγεννήθημεν;

Grec ancien.

Какъ же мы слышимъ ихъ говорящихъ собственнымъ каждому изъ насъ природнымъ нарѣчіемъ?

Russe moderne.

Agus cionnas do chluin gach aon againn a theanga féin ar ar gcuid tíre?

Irlandais.

कथं वयं प्रत्येकम् स्वजन्मदेशीयभाषाभिः कथा श्रोतुं इच्छुकः किमिदं

Sanscrit.

तो हमारे अपनेर जन्म देशके बोलोमें उन्होंको बातें किंतरह सुनतेहैं।

Hindoui.

ನಮಗೆ ತೆಂಗಮಾಣ್ಡಿಕಂಗಿಲೆಯವರ್ ಕಂಬೇಸ, ನಾಮ್ಯಾವರುಗಕೇಟ್ಗಿರ್ರೇ-ಮೆಷ್ತಿರುವಡಿ ಯಾಯಿರರ್ರು

Tamoul.

Ըւ գիարդ լսեմք մեք յիւրաքանչիւր բարբառս մեր յորում ծնեաք եմք:

Arménien moderne.

بس چگونه است که ما هریکی لغتی را که در آن متولد شده ایم از ایشان می شنویم

Persan.

ΟΥΟΣ ΠΩΣ ΑΝΟΝ ΤΕΝ-ΣΩΤΕΜ ΦΟΥΑΙ ΦΟΥΑΙ ΜΜΟΝ ΘΕΝ ΤΕΝΑΣΠΙ ΕΤΑΥΣΦΟΝ ΝΘΗΤΣ.

Cophte.

አንደት : እዮ : ኢያንደንደችን : እንሰ ማትቀለን : በተወለደብት : በቋንቋች ን : ሲናገረ ::

Amharique.

FIG. 4.—ANCIENT AND MODERN ALPHABETS.

There is a close analogy between the Hebrew characters and the ancient Assyrian cuneiform or arrow-head inscriptions. From the Sanscrit are also derived the Dravidian, Tamul, Telinga, and Canarese tongues, which are spoken in Southern India. Manchu and Kalmuck alphabets are, like those of all the peoples that inhabited the north of Asia, derived from the rounded block of basalt, and was discovered near the site of Nineveh, on the Tigris River. In Fig. 2 is represented a series of Egyptian hieroglyphics, which modern Egyptologists can read with perfect facility. Fig. 3 shows the incomprehensible Central American hieroglyphics. Both of these systems are more ideographic—that is, more in the nature of

MEN OF SCIENCE FROM ABROAD.

No occasion has before drawn together so many distinguished men of science from abroad, in various departments, as the Centennial Exhibition at Philadelphia. Without attempting to enumerate all whose names might properly be mentioned in this relation, we recall, from Great Britain, Sir William Thomson, the well known physicist who is President of the Judges on the XXVth Group—Instruments of Precision and Research; Sir John Hawkshaw, the eminent engineer who was last year President of the British Association; Sir Charles Reed, President of the XXVIIIth Group of Judges—for Education and Science; Capt. Douglas Galton, President of the Judges under the XVIIIth Group—Railway Plans, etc.; Mr. Isaac Lowthian Bell, the most eminent iron metallurgist in Great Britain, and author of the well-known treatise on the "Chemistry of the Blast Furnace," President of the Judges of Group I.—Minerals, Mining, Metallurgy, etc.; Dr. William Odling, Waynflete Professor of Chemistry in the University of Oxford, Secretary of the board of Judges on Group III.—Chemistry and Pharmacy, etc.; from Sweden, Prof. Adolf E. Nordenskiöld, Prof. C. A. Angström, Polytechnic Institute, Prof. O. M. Torell, Chief of the Geological Survey of Sweden, and Richard Akerman, of the Royal Swedish School of Mines, all from Stockholm, under whose immediate superintendence the excellent geological, mineralogical, and metallurgical display of Sweden, at the Exposition, has been made; from Russia, Major-General Axel Gadoline, an eminent Russian engineer, and Prof. L. Nicholsky, Mining Engineer and adjunct Professor at the Mining School of St. Petersburg, who is in charge of a systematic collection of Russian minerals—the only systematic mineral collection in the Exposition; from Germany, Dr. Wedding, Royal Prussian Counsellor of Mines, Dr. Rudolph Von Wagner, the well-known editor of *Wagner's Jahresbericht*, and Dr. G. Seelhorst, of Nuremberg; from France, Mr. L. Simonin, J. F. Kuhlman (*fils*), M. E. Levasseur, and M. Emile Guimet, of Lyons; from Italy, Prof. Emanuel Paterno, of Palermo; from Mexico, Mariano Barcena, the mineralogist.—*American Journal of Science and Art.*

RAILWAY BRAKES.

IN a recent address before the Society of Arts, London, Mr. F. J. Bramwell said: Concerning brakes, they acted usually by arresting the wheel and causing it to act as a sledge. There were continuous brakes and brakes only applied to the tender and to the brake van occupied by the guard. If they converted a wheel when it was revolving into a sledge, the resistance was equal to one sixth part of the weight; if the tender weighed 18 tons, and its four wheels were converted into four sledges, there was a resistance of three tons. As to the time and distance, take a train weighing 160 tons, and going at the rate of 30 miles an hour. In that case it would have the velocity due to a fall of 30 feet. But the train of 160 tons travelling at the rate of 30 miles an hour would have a stored-up energy equal to 4800 foot tons. If they pulled that weight through one foot it would represent the energy of that train. So, by increasing the resistance, they decreased the distance the train would travel. It was, therefore, plain that they could calculate the distance within which a train could be brought to rest. That distance would vary with the square of the velocity. In a train such as he had instanced, weighing 160 tons, the tender and two guards' vans would weigh 42 tons. When the wheels were converted into brakes they would act with a force of $\frac{1}{7}$ of that, or 7 tons. If the train, therefore, were going at 30 miles an hour, it would bring it to rest in 230 yards. In practice, brakes could not be put on the moment they are wanted, and required double the distance given by the calculation. It might have been thought that much could be done by the reversal of the engines. They would see that the brakes on the tender and the two guards' vans had a resistance of 7 tons, while the tractive force of the engine was 1½ tons. By reversing the engine, they only converted 7 into 8½ tons, and the reversal of the engine was by no means a judicious mode of aiding the brakes. The reversal of the engine was an excellent way of working a train down an incline, or when they wanted some brake power for doing the work at stations. M. Le Chatelier, who died some two years ago, was the inventor of the *contre-vapeur* system. In it a small jet of water was injected into the cylinders, and was there converted into steam by the heat arising from the momentum of the train thus suddenly stopped. The heat was thus absorbed instead of being allowed to affect the cylinders injuriously. The ordinary way of working was by the two break vans, but there had recently been a great demand for the continuous self-acting brake, and some very careful experiments had been made. A late friend of his, a past president of the Institute of Civil Engineers, used to relate that inventors came to him and said they had a brake which would stop the train dead. "Then you have something to kill all the passengers," said he. But they might dismiss that risk from their minds. The best brake they had did not do much more than take 2¾ miles velocity out of a train in each second of time. See what velocity any person under the influence of gravity would obtain in each second of time. In a second of time a falling body would attain a speed equal to 30 miles an hour. They might fairly compare putting speed into the body and taking it out. A swing when in the middle of its course travelled at the rate of 30 miles an hour. Yet that was all taken out before it came up to the horizontal line, which would happen in 1¼ seconds. That 30 miles had been taken out at the rate of 17 miles in a second of time. Recollecting what the best brakes they had would do, they need not fear being killed by the shock. At a colliery near Wigan there were 806 yards of winding from the bottom to the top. They must stop perfectly accurately, or the cages would go over the drum above. In the middle of its course the speed was 58 miles an hour. They did not check that until they were within 180 yards of the top, so that they stopped that 58 miles an hour in that space without injury to any one. But if continuous brakes did enable them to be brought to rest in a very short time, they would become universal. They were by no means an unqualified good, for when the wheels were converted into sledges, flats were worn on them. That now only occurred, and of course caused jolting, in the brake vans, but if the brakes were made continuous, the same thing would happen all along the train as the wheels became subject to that kind of wear. Excessive brake power was not always useful in cases of accident. Sometimes it was productive of absolute harm. If a wheel of a carriage broke, and that carriage was coupled up tight with the carriage in front, so long as there was motion in the train and it was brought gradually to rest, no harm took place. But if continuous brake power were used, the train would be suddenly arrested, and the carriage no longer supported would cause an accident. Continuous brakes, in fact, would be an unalloyed good, if the engine driver had time to think of what was best to be done, or if he always knew what was best. That was not possible; but, on the balance of evils, Mr. Bramwell believed continuous brakes were a benefit. On some railways the express trains were provided with them, and he believed at the first station from London they stopped the train by means of them, to see that they were in order. But after that they used the ordinary brake, except in cases of accident, or to avoid collision. He would mention a matter that caused him extreme surprise—the height which Capt. Shaw told him London firemen were in the habit of jumping. Any of his men, he said, could jump 20 feet, and some jumped 30. But it made a great difference upon what body the impact was made. If a man fell on the pavement he broke his arm, but on a carpet he did not do so. Yet the thickness of the carpet was very slight. In the same way at rinks one heard of broken limbs, but there were few such accidents on the ice, because in the latter there was a slight elasticity.

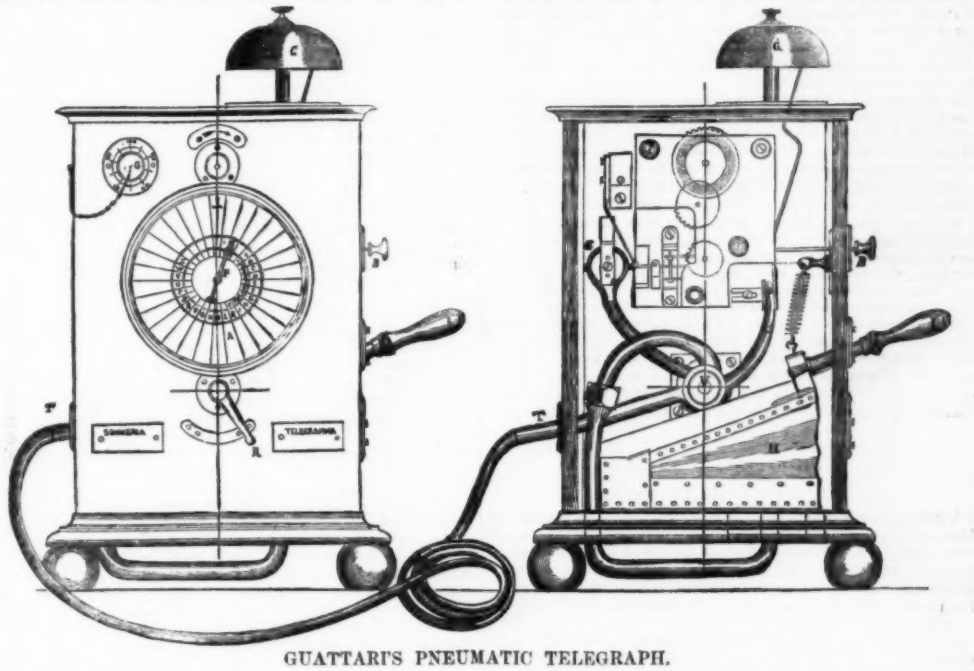
TAKING UP WATER WITHOUT STOPPING.

MR. BRAMWELL described, by aid of a diagram, how a pipe let down from the tender dipped into a trough in which was from four to five inches of water. The mouth of the pipe scooped up the water, and a velocity of 16 feet would send the water up the pipe, and would fill the tender. The difficulty as to the proper place for lowering and raising the pipe was met by giving the rails for a few yards before arriving at the trough a slight rise, the top of the hill being reached opposite to the end of the trough. That carried the pipe over the end of the trough, and the engine going down a corresponding hill immersed the orifice in the water. At the further end of the trough the hill was repeated in the rails, and the pipe was carried clear of the trough. An engine could thus take in 1500 gallons of water without stopping.

CENTENNIAL EXHIBITION.—The first calendar month of the Centennial Exhibition closed with the evening of the 9th June, and the attendance for that time just turned 1,000,000 visitors.

GUATTARI'S PNEUMATIC TELEGRAPH.

FOR local purposes and short distances, so as to connect different parts of buildings, factories, etc., the pneumatic or air-pressure telegraph has of late been successfully introduced. The pneumatic telegraph is operated by compressing a quantity of air in a rubber receptacle and forcing the same through their connecting pipes to act on a second distant receptacle that is held compressed when in a state of rest. The expansion of this second receptacle actuates a bell or other signalling apparatus. The apparatus is, however, not applicable to greater distances, as the volume of air in the communicating pipes is too large to be compressed with considerable power by the pressure exerted by the first receptacle, especially as such pipe connections can not be kept tight enough to prevent the escape of air. The Italian engineer Guattari has overcome in a simple and ingenious manner some of the difficulties of these telegraphs, by substituting, in place of a few powerful compressions, a quick succession of alternating compressions and dilatations, which produce, so to say, an oscillating motion of the air in the pipes. Our illustration shows his pneumatic telegraph at one side in elevation, and at the other side in section, with the interior arrangement. The air is set in motion by a bellows M, that is worked by a handle I, and a spiral spring. A cock V is set by a crank R so as to connect the pipe leading to the bellows either with receptacle or bulb D, or with receptacle E. The oscillatory motion of its air, produced by the working of the bellows, actuates either one or the other of the elastic receptacles, and produces either the working of a lever that sounds a bell G, or transmits, analogous to the motion of the armature in electro-magnetic telegraphs, the oscillating motion of E to a train of gear wheels that moves the hand F on a dial A according as the crank is set. The button B serves to return the hand to the starting point indicated by a cross, while the button G regulates a spring of the wheel train according to the length of the pipe connection. The apparatus works reliably for distances from 100 to 1000 metres, and the inventor has built an apparatus that works successfully for the distance of several miles.



GUATTARI'S PNEUMATIC TELEGRAPH.

CLAMOND'S THERMO-ELECTRIC BATTERY.

By LATIMER CLARK, C. E.

THE latest form of pair employed by Clamond consists of an alloy of two parts of antimony and one of zinc, as the negative metal, and ordinary tinned sheet-iron as the positive element—the current flowing at the heated junction from the iron to the alloy. The alloy is in the form of a flat bar, broader in the middle than at the ends, and measuring 2 to 2¾ inches in length, by ⅜ths of an inch to 1 inch in thickness. The sheet-iron, after being stamped out, is fixed in a mould into which the melted alloy is poured; before the alloy has cooled the mould is opened and the bars are removed. The alloy melts at a temperature of 500° F., and expands considerably in cooling; the more frequently it is recast the more perfect does the mixture become, so that old piles can be reconverted with advantage. The alloy is very weak and brittle, and can be broken almost as easily as loaf sugar.

The bars are arranged in a radial manner round a temporary brass cylinder, a thin slip of mica being inserted between the tin lug and the alloy to prevent contact, except at the junction. The number of radial bars varies with the size of the pile: eight or ten are generally used. The bars are secured in their position by a cement formed of powdered asbestos and soluble glass, or solution of silicate of potass. As soon as one circle of bars is completed, a ring of dry asbestos is placed upon it, and over this another circle of elements is built, and so on until the whole pile is completed. The entire structure is consolidated by means of cast-iron frames placed at the top and bottom, and drawn together by screws or rods. The inner face of each element is protected from excessive heat by a tin strip, or cap of tin bent round it before it is imbedded in the cement; the projecting strips of tin from the opposite ends of each pair of elements are brought together and soldered with soft solder by means of the blow-pipe. The positive poles are always placed at the top.

The pile is heated by gas mixed with air, on the Bunsen arrangement—that is to say, the tube up which the gas passes is pierced with a number of small holes, and these approximately correspond in position, as well as number, with the elements employed. Through an orifice in the gas supply tube, a regulated proportion of air passes, and this mixes with the gas before entering the tube forming the chimney. Through the small holes the mixture escapes, and in the annular space between the tube and the elements, it burns in small blue jets, the products of combustion being carried off at the top. When combustion is going on properly, the earthenware tube glows with a dull cherry-red color, and none of the jets should impinge on the elements. By means of an excess of gas, the pile may be overheated and the connections of the elements destroyed; when in good order, the temperature of the inner bars should be about 400° F., and that of the outer about 200° F.

To prevent, as far as possible, injury from overheating, and at the same time to lessen the consumption of gas, Clamond has recently introduced a new form of pile, from which he derives considerable advantages. The mixture of gas and air is still burnt as before in the earthenware tube; but this, in place of extending up the whole height of the battery, is carried up to only about half its height. The earthenware tube in the new arrangement is surrounded by an iron tube of greater diameter, which is carried up almost to the top of the battery, and is open at the top. The elements are placed in the usual way outside the iron tube, and from the bottom of the annular space intervening a chimney leads off. The top of the pile is covered over by a closely fitting movable cover. The air enters at the bottom of the iron tube, and the heated gases pass upwards to the top; finding no means of escape there, they curl over, and descending outside the iron tube—that is, between it and the elements—they finally make their exit by means of the chimney already referred to. The elements are thus heated partly by radiation from the iron tube and partly by the heated gases on their way downwards to the chimney. Not only is the danger arising from the gas jets impinging on the elements thus removed, but the consumption of gas is said to be reduced by one-half. Should a bad connection occur, it is short-circuited by a piece of wire, and a defective element can readily be cut and replaced by a sound one.

A small gas regulator (to keep the pressure of gas, as far as may be, constant) is employed with each machine. The consumption of gas in small-sized elements is stated to be about one foot per hour for each volt of tension. Where gas is not available for heating purposes, coke or charcoal is found to answer very well. Paraffin oil might probably be employed with advantage, although thus far it does not seem to have been successfully used as a source of heat in the thermo-piles.

Iron screens are sometimes employed to surround the pile, their object being to cool the external surfaces of the elements by causing a current of cold air to pass over them. They likewise prevent, to some extent, the fracture of the bars which takes place if the pile cools too rapidly. The subject of screens and other mechanical appliances for cooling the external surfaces of the thermo-electric elements, such as currents of air, the use of water, evaporation of moist surfaces, etc., have thus far been imperfectly investigated, and throw open a wide field for research, notwithstanding the labors of M. Clamond.

The electro-motive force of a thermo-electric element, such as those employed in Clamond's pile, is such that twenty elements may practically be regarded as equivalent to one Daniell's cell in this respect—that is, they give about one volt.

They are made by the Thermo-Electric Generator Company, London, the sizes being 2 volt, or 40 bars, price $15, up to 34 volt, or 680 bars, price $160.

It is found that the electro-motive force of the several layers of elements varies, owing to the fact that some are more fully exposed to the heat than others. The middle layers seem to give the best results, although when first heated the upper bars are stated to give the greater electro-motive force.

So extremely sensitive are the thermo-electric piles, that it is all but impossible to find one in such a state of equilibrium as to give no evidence of a current. If it be so, the passing of the hand into the interior of it, breathing upon it, or even the approach of the body, immediately sets up an action; and whilst they are at work, the effect of a distant fire, or the opening of a window, will produce a sensible effect upon them. When two or more piles, therefore, are employed, they should, in order to secure the best working, be kept as far apart as possible, and allowed free radiation.

Electro-deposition is one of the many uses to which thermo-electric piles may be turned, and they are already largely employed for electro-plating. As an instance of what has been done, a battery of 375 elements (whose internal resistance was 4.5 ohms, and electro-motive force 14.6 volts) deposited about 180 grains of copper per hour, but then the electro-motive force was sufficient to have created a similar deposit in several successive cells, so that no practical results have yet been made known which could be accepted as a theoretical possibility of the work to be effected by them in this respect.

The mechanical power obtained from thermo-piles by electro-magnetic engines has not yet been put to any practical use, nor can it be looked for as ever likely to be worked from

an economical point of view. The electric light furnished by them is powerful and constant, but a very large number of elements has to be employed in order to secure this.

For laboratory use they are very handy, and by utilizing the waste heat of kitchen fires they might doubtless be employed to considerable advantage for domestic purposes.

LIGHTNING CONDUCTORS.

M. R. F. MICHEL has lately made two interesting communications on the subject of lightning conductors to the Académie des Sciences, Paris.

For some years the use of copper wire ropes has been recommended for this purpose, this metal being a much better conductor of electricity than iron, and the ropes formed from it lending themselves readily to the architectural contours to which they might be attached. But, besides the fact that the high value of the metal affords too great a temptation to the cupidity of the workman, the ropes themselves frequently undergo considerable deterioration under the action of the electrical currents passing along them, of the atmosphere, and of the vibrations to which they are exposed; the copper becomes crystallized and brittle, the wires snap one after the other, and the consequence is that in a short time the available sectional area of the rope is considerably reduced.

The author also calls attention to the very defective method of manufacturing these cables, whether of copper or of iron. When it is desired to join a wire accidentally broken, or of insufficient length, the two ends are merely twisted together, without any precaution being taken to secure the proper contact at the joint. Oxidation ensues, and it may happen that the conductive power of the rope is materially lessened, and even completely destroyed. The conductor should, therefore, be formed of iron rods welded together, or of a rope consisting of large wires with no joints; plates of copper, however, seem to possess considerable advantages for this purpose, without any of the drawbacks mentioned. The Paris Bourse has a ridge cover of copper connected with the lightning conductors, which was put up a long time ago, but is still in a perfect state of preservation and electrical conductibility, as proved by some recent delicate tests.

In the second communication the author states that for the last year he has undertaken a microscopical examination of the points of lightning conductors, and has also subjected them to chemical analysis. The result has been that about 40 per cent of the points examined were found to contain from 6 to 17 per cent of lead. Some points, even of small dimensions, had been hollowed out inside, so as to leave a shell of only 0.75 of a millimetre thick, and into the cavity thus made a composition of equal parts of lead and tin had been run. After cutting one of these points, and placing it in a crucible raised to a dark-red heat, the fusion of the composition left an empty space, and in some of the platinum points the composition adhered so slightly as to be easily removed by the aid of a punch.

At the time of the inquiry into the state of the lightning conductors surmounting the municipal buildings, M. Michel found that the proportion of platinum points bent, burnt, or fallen off, amounted to 80 per cent, and he has come to the conclusion that it is quite impossible to verify the state of the platinum points of lightning conductors.

SHOOTING STARS.

By Prof. C. A. YOUNG.

THEY are very small, for the most part, as Newcombe and Harkness have shown, weighing certainly not more than a few grains, and possibly only some thousandths of a grain, mere particles or cloudlets of dust, which are travelling in space under the same laws as th se which govern the motions of the planets and comets, and with a velocity as great; varying in different cases from 8 or 10 miles per second to 40. The least velocity named is more than thirty times that of a cannon-ball. When they encounter our atmosphere this velocity is destroyed by the resistance, and according to well-known laws, their energy of motion is converted into heat of intensity sufficient to render them incandescent, and even to dissipate any solid portions in vapor.

It is the amount of light they give which furnishes the evidence as to their minuteness, but it would take too long to show just how the conclusion is arrived at.

Their numbers are very great. It is found that one observer will on the average see from 4 to 6 per hour at any given place, and careful experiment shows that a single person sees about ¼ of all that could be seen by a sufficient number of observers so placed as to watch minutely every portion of the sky. About 40 per hour is therefore a fair average for one station, or nearly a thousand each day. If the calculation is carried out for the whole earth, allowing that at each station all are observed which come within a circle 200 miles in diameter, we find the total number that reach the earth daily is about 5 millions; indeed, Professor Newcombe, who is perhaps the highest authority on this subject, sets the number still higher, at 7½ millions. A curious fact is that the hourly numbers increase from sunset to sunrise by some 50 per cent. The reason is simply that in the evening we are, so to speak, behind the earth as it rushes through space, and see only those which overtake us; in the morning, on the other hand, we are in front, and see all we meet, as well as those we overtake.

Of course, if meteors are thus perpetually entering the atmosphere, it is natural to ask, What becomes of them? Do they reach the earth? Probably, as impalpable dust. Nordenskiöld, during the recent arctic expedition, examined with great care quantities of snow from regions apparently beyond the reach of all human adulteration, and on melting the snow and evaporating the water he always found a residue consisting largely of *iron* and its oxides. This he considers to be of meteoric origin, and it is not improbable, considering how important a constituent iron is found to be in those larger masses, the aërolites, which from time to time fall upon the earth and are collected into our cabinets. —*Boston Journal of Chemistry.*

THE SATELLITE OF VENUS.*

AN indirect result of the recent Transit of Venus has been the revival of a nearly forgotten but not uninteresting speculation as to the possible existence of a satellite accompanying her. Nothing of the kind was observed on the late occasion, but the planet's path was so far from central that an attendant might readily have remained outside the solar disc; and therefore, though the negative evidence, if it had required additional strength, would have received it from this non-appearance, it would not have been rendered absolutely conclusive on that ground alone; and, so far as the Transit is concerned, there is still room for an essay like that before us, which, previous in composition though subsequently published, advocates the affirmative opinion. That opinion, after so many years of additional observation since Lambert's memoir in 1777, is not likely to find favor with astronomers now, and certainly will not be established by the present treatise. It is an unpleasant task to express any other than a favorable estimate of any work undertaken with a view to enlarge the boundary of knowledge; but in the present instance it is unavoidable. There is, indeed, a very considerable accumulation of historical matter, and there are some pleasant anecdotes, and a few valuable and little known facts; but the materials of some portions at least are neither complete nor accurate; the pretermission of recent discoveries—especially spectroscopic—is sometimes simply unaccountable; and the hypotheses occasionally partake of an extravagance that outstrips all probability. The subject is, however, as has been remarked, not devoid of some interest, nor, to say the truth, disentangled from some perplexity of an obstinate character; and it is worthy of a more satisfactory elucidation, which might be comprised in a narrow compass, as its literature is not extensive. A few remarks only can be attempted here.

That something strongly resembling a satellite has been occasionally seen near Venus, especially about the middle of the last century, is beyond a doubt. It is equally certain, and familiar to all experienced observers, that reflected images, or technically "ghosts," may, under certain circumstances, be formed in the eye-piece of the telescope, and might be the means of causing deception: and the whole matter is reduced to the simple inquiry, whether all the recorded instances admit of this easy explanation; though, if they do not, it must be remembered that the existence of a satellite would not necessarily follow.

Abbot Hell, who published an elaborate dissertation on the subject in the appendix to the Vienna Astronomical Ephemerides for 1766, seems to have been the first to study systematically the formation of telescopic ghosts. The Vienna Observatory was possessed in those days of two good English telescopes, left to it in 1757 by Cardinal de Trautson; a 2 ft. Gregorian, and a 4½ ft. Newtonian. About December in that year, the abbot, examining Venus with the former instrument and a power of 70 or 80, perceived a star of an ill-defined aspect near it like a little comet, but as it was invisible both in that Newtonian and in another of the same construction of 4 ft., he referred it to a reflection from the interior of the tube. In March, 1758, Venus being at her greatest elongation, the illusion returned, on which he blackened the tube, and for some days did not see it again; but when at length it reappeared, on moving his eye very gently towards the eye-piece he found it change into a perfect image of a satellite with the phase of the primary. Beyond the limit of barely half a line either way from this position, it was invisible. When Venus occupied the centre of the field, this "spectrum," as he calls it, was near the edge; as he moved his eye round, or up and down, the image moved the same way, generally disappearing in the neighborhood of the planet. A set of experiments instituted in consequence satisfied him that this image was formed by rays reflected first from the convexity of the "pupil" (cornea), and a second time from the concave face of the meniscus lens which in this case formed the eye-glass, though it would be shown by any eye-piece possessing a surface concave towards the retina. Cases were even possible, but difficult in management, when an image might be seen, though the object was not in the field; but this was formed by rays passing outside the telescope, and the ghost would be inverted and of much smaller dimensions. The magnitude of the image would depend on the proportion of curvature of the reflecting surfaces. This being once understood, the Abbot found that he could always produce, for himself or others, a spurious satellite of Venus, or Mars, or Jupiter, under the following essential conditions: That the power should not be less than 50 or 80, or the image would be too minute to be visible, or would only resemble a small star; that the eye must be placed at a definite distance from the eye-glass, and be moved most deliberately and cautiously backwards and forwards to find that point, the limit of visibility being sometimes only a quarter of a line either way; and that the eye must be a little on one side of the optical axis, or the image will coincide with its primary. And it becomes readily intelligible why an observer, ignorant of these conditions, may never be able to recover an image which he had once accidentally seen. Thus far, in substance, the astronomer of Vienna, who certainly deserves credit for his ingenious and careful investigation. His reasoning is, nevertheless, a curious and instructive exemplification of the way in which a preconceived opinion may block up the mental view, and prevent a sound argument from being carried out to its legitimate consequences.—*Nature.*

* "Der Venusmond," etc., von Dr. F. Schorr. Braunschweig, 1875, pp. 186. T. W. Webb.

A NEW DOUBLE-REFLECTING TELEMETER.

TELEMETRY, or the art of determining rapidly and accurately distances on the earth's surface, apart from its numerous economic applications has become absolutely indispensable in the use of modern weapons of war. Various mechanical devices for these purposes have been invented, but none hitherto similar to that illustrated, devised by Lieutenant Gaumet, French army, which is adapted for carriage in the pocket. A perspective view of the instrument is given in Fig. 1. Fig. 2 shows the interior. Two mirrors are disposed on a metallic plate so that an angle of 45° is made between them. One mirror is fixed; the other is mounted on a movable alidade, so that the above angle can be varied from 41° to 49°. A micrometric screw of .04 inch travel per turn has a disk on its head, which is divided circumferentially into

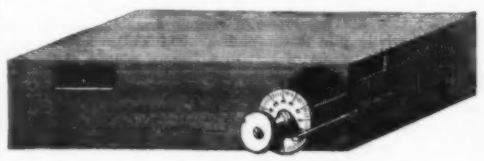


FIG. 1.

100 parts. This screw moves in double nuts on the metallic plate. The disk travels in front of a divided rule, each division of which equals .04 inch. A spring causes constant contact between the arm of the alidade and the extremity of the micrometric screw.

All the above parts are contained in a rectangular box, as shown in Fig. 1, having at its rear an opening for the eye, and on the right side a similar aperture through which the rays pass to the mirrors. The principle on which the device is constructed is a simple application of that of double reflection. When a luminous ray is reflected successively by two mirrors placed in a plane perpendicular to the intersection of the mirrors, the angl formed by the incident and the reflected ray is double the angle of the mirrors.

In order to measure a distance by the instrument three operations are necessary. These will be understood from Fig. 3, and are as follows: 1, to determine the right angle C A M; 2, measure a base A B; 3, measure an angle at A C B, A C being the distance to be determined. The observer posts himself at A, the point C being on his right. The re-

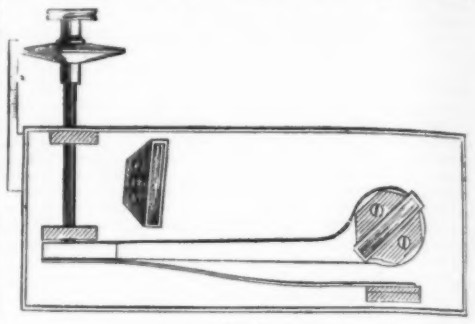


FIG. 2.

flected image of this point then appears directly above the direct image of the fixed station M, which is regarded in direction perpendicular to A C. (The angle C A M is right whenever the two mirrors make an angle of 45°.) The observer now, by means of a tape provided with the instrument, measures off a distance along the line A M of A B = 60 feet. He then proceeds to B and regards anew the signal point M, between which and C there will no longer be a coincidence, the latter appearing to the right, say at C'. To re-establish the coincidence the movable mirror is turned to an angle equal to ½ C' B M, which equals ½ A C B. The angle of rotation of the mirror is in the instrument measured by its tangent by the aid of the micrometric screw. This gives a very close approximation. When the coincidence above referred to is obtained the number of turns made by the screw is read from the scale, and this equals the measure of the tangent of the angle of rotation of the mirror. This angle of rotation is half the angle A C B. The relation, therefore, between the distance from the pivot of the movable mirror to the axis of the micrometric screw and double the

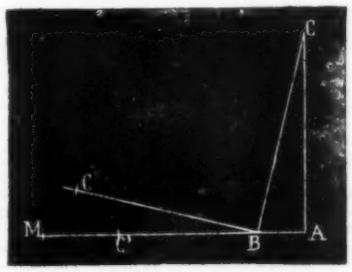


FIG. 3.

number of d visions equals the ratio between the unknown distance and the base measure. Therefore, D being the distance to measure; b the base taken, say 60 ft.; l the distance of the pivot as above, which in the instrument is 2.2 inches, and n the number of divisions, we have

$$\frac{D}{b} = \frac{l}{2.n}. \quad \text{or } D = b\frac{2.2}{n}.$$

Whence we obtain for each instrument a constant which, divided by the number on the scale, at once gives the distance sought. On every instrument a table prepared from the above formula is fixed so that the observer merely has to glance thereat to determine the distance without calculation.

This invention is in principle the same as that patented in the United States, March 16, 1875, by Mr. William F. Hausch, of Chicago, Ill.

HOW PLANTS FEED.

DR. SACHS recently delivered a lecture on this question before the Frankischen Gartenbau-Verein, in which he reviewed the present state of our knowledge as enriched by the latest investigations. The following is mainly the substance of the lecture, as abstracted from the *Gardeners' Chronicle*. It contains, as a matter of course, many well-known facts, but they are put together in a form that will be welcome to those who have not time to cull them out of scientific books. With regard to successive periods of nutrition and growth, we have only to mention bulbous plants, germinating seeds, and the unfolding of the buds of trees in spring. It is true that water, which is necessary for the enlargement of the organs, is taken up, but there is essentially no storing up of food at this period; on the contrary, there is a consumption and exhaustion of the nutritive substances previously accumulated in the plant. The fact that this process is perfectly effected with distilled water is accepted as a proof of this assumption. The enlargement of the growing parts is effected solely by the absorption of water, and therefore the whole operation is essentially one of a change of the "reserve substances" already present. On the other hand, the horse chestnut, walnut, and other trees, present us with examples in which the conditions are reversed during the summer months. The formation of branches and leaves ceases, and large quantities of nutritive substances are stored up in the tree, and not appropriated till the following spring. Again, there are many plants, especially those of annual duration, which grow during the night when nutrition is not proceeding, and in which both operations are carried on simultaneously during the day. In these cases it is in the roots and fully developed leaves that the process of nutrition is going on, and growth in the buds, flowers, and fruit.

With regard to the sources of the food of plants it has been proved by direct experiment that they receive by far the greater part of it from the atmosphere through their green leaves. The small quantity of ash that remains after burning a plant, together with a large proportion of the water contained in the plant, represents what is taken in by the roots from the soil. This ash consists chiefly of alkalies, lime, magnesia, of phosphoric acid, sulphuric acid, chlorine, and silicon, mixed with a

very minute proportion of iron. Although these substances, taken altogether, form only a very small fraction of the total weight of the plant, they are indispensably necessary to its nutrition, as has been proved by numerous carefully-conducted experiments; and although they are present in only such very minute quantities, the absence of any one of the substances named, with the exception of silicon, is sufficient to prevent a plant from thriving and attaining its proper development. The insignificance of the quantity of the ash constituents is therefore no guide to their importance. Every cultivator is aware of the fertilizing properties of even a very slight dressing of wood-ashes. Besides the incombustible constituents and water the roots extract nitrogen—another important element in the food of plants—from the soil. This is taken up in the form of nitrates and ammonia salts, which are both compounds of nitrogen and other elements. The nitrogen is not found in the ash, as it is dissipated in combustion. It forms only a very small fraction of the organic substance of the plant, but the amount is easily determined by a chemical process, which we have not space to describe here. The great bulk of the substance of a plant consists of carbon, in various combinations with hydrogen and oxygen, and forming alone usually about half the dry weight of the plant.

One of the most brilliant discoveries of the latter part of the last century was the fact that this enormous quantity of carbon stored up in plants is taken up by their leaves from the atmosphere, which apparently contains only so very small a proportion of it. It is present in the atmosphere in combination with oxygen, as carbonic-acid gas, to the extent of only about four parts in ten thousand. This apparently small proportion of carbon in the atmosphere, and prejudice, for a long time supported the notion that plants obtain some of their carbon from the soil, and manures rich in this element were regarded as their principal source of nutriment. But now it has been proved that all green-leaved plants obtain the whole of their carbon from the atmosphere. Therefore, decayed vegetable matter, or carbon compound in any form, may be spared from the soil, so far as the healthy condition of the plant is concerned; and it is only necessary that the incombustible constituents and nitrogenous compounds should be present, for, as a matter of fact, the quantity of carbon in the atmosphere, though constituting so small a proportion, is practically inexhaustible. The value of the discovery of the source of the carbon of plants to the cultivator is simply inestimable, because it would be impossible to find soil sufficiently rich in humus for cultivation on a large scale. Now, two conditions are essential to enable the plant to draw its carbon from the atmosphere—namely, green (chlorophyll-holding) tissue in its leaves or branches, and these green organs must be exposed to a sufficiently strong light. It is only under the influence of daylight or of direct sunlight that leaves are able to absorb and decompose carbonic-acid gas. The oxygen set free is returned to the atmosphere. The carbon combines with the elements of water, and an organic substance is formed, which subsequently may be used in the further growth of the plant. It is unnecessary to insist on the necessity of affording as much light as possible to plants, according to their nature, for practical men are well aware of its importance and effects.

According to the amount of light, so we should regulate the heat of the atmosphere in cultivating plants under glass; for heat means growth of the plant, and light nutrition. Heat, therefore, without adequate light, means growth without nutrition, or self-destruction of the plant, whilst warmth and sufficient light signifies growth and enough nutrition. But it does not follow, as is commonly supposed, that because plants absorb carbonic acid and liberate oxygen, they purify the air of a room, for in the absence of sufficient light (and subjected to other antagonistic influences) they decompose very little carbonic acid. Indeed, under the best circumstances, the improvement in the atmosphere of a room would be scarcely appreciable. Another important fact remains to be mentioned. The respiratory process in plants is the same as in animals, in so far that the former also absorb oxygen from the air and exhale carbonic-acid gas. True, this is on a very limited scale, and a healthy plant absorbs far more of the noxious gas than it gives off. Nevertheless, it is not desirable to have large masses of plants in dwelling rooms, inasmuch as the conditions here are not conducive to healthy growth, and the purifying powers of the plants are reduced to a minimum. Plant-growing in schools has been recommended for purifying the air, and there is nothing to be said against the presence of the plants, but it should be remembered that a window open only a very little way will effect more towards keeping the air pure than a room full of plants.

GUARANA.

THE *Paullinia Sorbilis*, belonging to the family of Sapindaceous, and to the species of Paullinian plants, grows in the gardens of Brazil. The leaves are pinnated; the stalk is apterous; the blossoms are bijugate, oblong, and dentate-sinuate. The black seeds are pounded, roasted, formed with water into dough, and made into bread, and thus constitute guarana. So far as I know, Martius was the first to make Europe acquainted with the use of this substance. Travellers take the dried guarana loaves with them on their journeys, soak pieces of the cakes in water, and thus prepare a drink which, sweetened with sugar, has very exciting and invigorating qualities. It is likewise called Brazilian chocolate. The name *Guarana* comes from the *Guaranis*, an Uruguay tribe.

From the day when I became acquainted with guarana in Brazil, and in the northern provinces of the Argentine Confederation, I have striven to snatch it from the hands of imposture, which speculated in it as a medical remedy of much value, and which puffed it in the advertising columns of newspapers; and I have endeavored to assign it its true place in the glorious array of nervose aliments. And in truth, if the fruit of the *Paullinia* is of small import as a medical remedy, it is eminently worthy of being placed beside coffee and tea as an excitant of the brain. Guarana has not been known to Europeans more than about half a century. Cadet De Gassicourt got into his hands, in 1817, a fragment of it, which he obtained from an officer connected with the French Embassy at Rio Janeiro; and it was recommended to him as a useful remedy in diarrhœa, in dysentery, and in some affections of the bladder. The Indians of the Amazon use guarana habitually, grating it with the hard and very rough tongue of the *Vastres gigas*, or *Sudis gigas*, a fish of the salmon tribe, and steeping it in water. On their travels they always carry with them a large quantity of guarana, which serves to sustain their strength and to exhilarate them. As aliment on journeys, guarana has assuredly no rival; because it resists the sun, humidity, putrefaction, time; and a drink from it can be improvised wherever cold water can be found. In this respect it is superior to all other caffeicals, which require processes of torrefaction, hot water, sugar, and infinite trouble in their conservation. It may be stated that in the Antilles the precious virtue of rendering eloquent is attributed to guarana. I have found very efficacious for animals and for man a guarana already musty, and which could not have been less than forty years old. I have no doubt that guarana could be preserved for a century, and that it would be found of equal value by travellers at the Pole and in the African deserts. Guarana is used by Europeans established in Brazil, especially in the province of Mato Groso, where it is of all beverages the most popular. The rich in Bolivia employ it as a tonic, as an excitant of the intelligence, and as an aphrodisiac. I knew a President of Bolivia who for many years made a daily, and certainly very abundant use of guarana; and he said that he was indebted to this beverage for a vigor of mind and body rare at an age so far advanced as his was. The literary men in that country likewise take guarana to keep themselves awake when they have to work at night. It is only in these last years that the use of the Paullinian paste (guarana) has been spreading in the provinces of Salta and Jugui, which, by position, products, and customs, may rather be called Bolivian than Argentine. Of the other countries that use guarana as nervose aliment I can say nothing; but I hope that my imperfect studies may aid in extending in Europe the use of one of the most salubrious beverages which can gladden us and make us robust in our mind and in our nerves.—*Mantegazza*.

SOCIETY OF ANTIQUARIES, LONDON.

REAR-ADMIRAL THOMAS A. B. SPRATT, C.B., exhibited a marble statue of Venus, which was discovered about twenty years ago at Gnossos, in Crete. The head, of which the upper part is lost, was found about 200 yards away from the body. The left arm is missing. The height of the figure is 23½ inches. The goddess is represented as preparing for the bath, removing her left sandal with her right hand. A draped pedestal, with a rudder standing beside it, is on her left side, and the raised foot rests upon a swan. A similar statue was found at Cyrene, and there are many instances of the same attitude, in bronze, at the British Museum and elsewhere. The head is small, though the forehead is high, and the proportions generally are more slender than is usual in Greek art. The leg also, as compared with the thigh, is longer than the Vitruvian canon allows. In these respects it resembles the works of Lysippus more than those of other sculptors.—A. W. Franks, Esq., exhibited a volume containing contemporary copies of documents referring to Arabella Stuart, and of two poems, one of which is evidently an appeal from her to James I., though perhaps not written by her. The other describes a vision seen by a man imprisoned in the Tower, but is rather obscure. The binding is of cut vellum, in imitation of lace. In the centre are the arms of Q. Elizabeth, with the motto "Semper eadem" beneath. At the corners are two T's and two A's with true-love knots. Mr. Franks suggested that these letters might designate Elizabeth or Isabella Lennox, Arabella's mother.—The Rev. J. Collingwood Bruce gave an account of recent excavations at South Shields on the site of a Roman camp, which will shortly be built over. The ramparts are clearly traceable. The walls are five feet thick, and in some places five or six courses are still left standing. The dimensions are 360 feet by 615 feet, a size equalled by few stations on the Roman Wall. The four gates are not placed in the centre of their respective sides. At the eastern gate the guard-chamber was found, the walls being covered with colored stucco. In the centre of the camp was a small forum, containing an *aerarium* with very strong walls clamped with iron, and sunk beneath the level of the ground. The five steps by which it was entered were still in their original position. The character of the masonry was good throughout, and the stones large, being principally freestone and magnesian limestone. From the tooling still visible on some of the stones Mr. Bruce conjectures that the building is of the time of Severus. On the west side was the burial-ground, where, among other remains, a skeleton was found, covered with a tomb rudely built of slabs of stone. Several skulls and bones were found in the *aerarium*, probably the relics of soldiers slain at the time of the evacuation of the station by the Romans. The coins were mostly of the Emperors Trajan and Valens. Among other objects were four or five swords, from two to three feet long, with wooden scabbards and bronze chapes; lamps, fibulæ, a stone fir-cone, bones and horns of deer and oxen, whelks, limpets, and oysters, the last of which are not found at present in the neighborhood.—Octavius Morgan, Esq., exhibited a long rowelled spur, of the fifteenth century, which was found during the present year in Parliament Street, at a depth of 18 ft. below the surface of the ground.—The Rev. F. G. Lee exhibited a carved wooden bowl with a cover of the time of James I., and Mr. Franks exhibited one of similar workmanship, but without a cover, on which were carved the arms of England and the letters "I. R."—*Academy*.

FUNCTIONS OF THE CEREBRUM.

THE last number of *Pflüger's Archiv* contains an account of some very important observations on this subject by Prof. Goltz, of Strassburg. The destruction or removal of any considerable portion of the cerebral hemispheres in animals so highly organized as the dog is usually followed by death after a comparatively short interval of time; and any observations that can be made have reference only to the immediate effects produced by the injury. This initial obstacle has been successfully overcome by Goltz. He succeeded in keeping several animals alive and in good health for weeks and months after large portions of one hemisphere (in one case, an entire hemisphere) had been destroyed by allowing a stream of water to penetrate into the skull through an opening made with the trephine. It was found that most of the striking phenomena manifested by the animals immediately after the damage had been inflicted were of a temporary character only, and disappeared in the course of time. Three sets of these phenomena were investigated. Any considerable mutilation of one hemisphere (no matter in what region) was invariably followed by great impairment of tactile sensibility, of musculo-motor power, and of vision, on the opposite side of the body. The hemi-anæsthesia was found to subside rapidly, but never completely, a certain bluntness of the sense of touch being discoverable by methods of appropriate delicacy several months after the animal had completely recovered from the immediate effects of the operation. The opposite eye, at first quite blind, gradually regains its power of seeing; but its functional restoration is never absolute, and it continues to exhibit certain very singular peculiarities. So with the motor hemiplegia; its coarser manifestations yield to time, but a residue of impairment subsists for months, and may possibly turn out to be permanent. How ought this sudden abolition of certain faculties, and their all but complete restitution, to be accounted for? The author passes the various theories advanced by Flourens, Carville and Duret, Schiff, Soltmann, Hitzig and Ferrier, under review, and finds that not one among them is capable of affording the desired explanation. A belief in the existence of localized centres in the cortical substance is alike incompatible with the fact that lesion of any part whatever of a hemisphere is followed by one and the same train of symptoms, and with the observed restoration of the particular functions over which those centres are supposed to preside. Goltz then proceeds to set up a hypothesis of his own, which he regards as adequate to cover all the phenomena. According to this, the primary effects of the cerebral lesion are due, not to paralysis, but to irritation. The centres for vision, for the perception of tactile impressions, for the co-ordination and discharge of muscular movements, are none of them situated in the greater brain, and are not, therefore, directly injured. They are temporarily inhibited, the restraining impulse being transmitted in a downward direction from the hemispheres. As the irritation caused by the injury subsides, the inhibitory influence subsides also, and the centres in question resume their functional activity. The small residue of permanent mischief remains to be accounted for; but it is by no means certain how far any of the residual phenomena deserve to be viewed as really *permanent*. That they last for months is no proof that they will last for years; and, until their permanence has actually been established, the author deems it superfluous to attempt to reconcile it with his theory.—*Academy*.

FIREPROOF TOWNS.

A CORRESPONDENT of the *Builder*, singing himself "Alma," writes:—It is curious that, while we have such disastrous and numerous fires in this and neighboring countries, and in North America, there are cities and towns not far off absolutely fireproof—as Buenos Ayres and Monte Video. In Buenos Ayres, a city of 250,000 inhabitants, a poor charwoman sleeps with her children with more safety from fire than the Princess of Wales and the royal children. Yet it is so easy to make houses fireproof, using wood, not to speak of iron, that the older architects and builders of Buenos Ayres and other towns there probably never knew they were building fireproof! They neither use iron nor the arch, but simply, that province being without trees, they have to use the hard woods from far up the river, which are, therefore, dear, and so they use little, this being the whole secret. A hundred walking-sticks may be placed 2 in. from each other, and yet a fire cannot be made of them, if they are placed gridiron fashion, say, across two little walls of brick and a fire kindled below; it will burn through, say, four of the sticks which are in the flames, but there it ends. In the same way, if a cart load of shavings and pieces of pine were provided, and half be packed under the best bed in a Buenos Ayres house, and the other piled over it and set on fire, the bonfire would eventually burn through four or five of the joists above, and the bricks and tiles of the floor would fall through, but there it would end; the house could not be set on fire. The houses are built as follows, the material being brick:—Alike each floor and the roof (which is flat) are supported by joists of hard wood about the same distance apart as in this country; across these are laid rails of the same (3½ in. by 1½ in.), and the space between these is bridged over by thin bricks 13½ in. long; another layer of bricks is then laid, and generally on this a layer of tiles. The roof is exactly the same, but has a slope of 1 in 30 or 35. Then the doors and windows have no boxes, but simple frames, which are set up on building the wall and built in; and there is no lathing, nor wainscot, nor skirting of the bottom of the walls. And all the wood is of the hard and hardish kinds, the doors and windows and shutters of cedar, slow to ignite. The modern houses of Buenos Ayres are pretty much like those of London, Bath, or Edinburgh, nor would any one see any difference. It would be easy, therefore, to adopt the same way of building here with the necessary slight modifications. The ends of the joists in the walls would probably rot in course of time, from external damp penetrating, if they were not of wood indestructible by damp, as in the River Plate towns, where, in the experience of the Spaniards, which extends to nearly two centuries, it does not rot in the damp in that time. Hence, if they were only of oak in this country, a *battre*, like a cornice, should be built at the top of the walls of each story on which the ends of the joists are to rest, so as to sustain them if their ends, built into the wall, ever rotted. The projection, stuccoed over, would form a cornice; but the joists could easily be of iron instead, this being the cheapest country for iron in the world. The lathing of the ceilings and walls should be done with iron ribbons, and the slates be supported by sheet-iron, to which they could be fixed by small screws and nuts. Then the coldness of the floors should be obviated by a lining of black poplar, ¼ in. or ⅜ in. thick, and carpets above; but all the rest to be of oak or teak, or other hard wood, both hard, and wanting in that resin which makes pine so combustible. Instead of filling our houses with combustible pine it would surely be better thus to copy the Spaniards in their fireproof towns—Buenos Ayres, Monte Video, Rosario, Paraña, etc.

THE OCEAN'S BOTTOM.

HER Majesty's ship "Challenger" was despatched towards the close of the year 1872, round the world, on a surveying and discovery expedition of a very special character. Her principal object as laid down in her instructions was to determine, as far as possible, the physical and biological conditions of the great ocean basins, the Atlantic, the Southern Sea, and the Pacific. A civilian staff of specialists in Natural Science and Chemistry was attached under the direction of Prof. Wyville Thomson.

One day, the ship being some 1600 miles from Sombrero, and in lat. 23° 23′ N., long. 32° 56′ W., the sounding-line indicated a depth of 3150 fathoms, and the bottom was found to consist of a perfectly smooth red clay, containing scarcely a trace of organic matter. This was the greatest depth as yet met with, and the material from the bottom was something quite novel to the explorers. At the mean maximum depth of some 2200 fathoms the ooze was one vast mass of the calcareous shells of foraminifera, but as the soundings got deeper the ooze began to assume a darker tint, and showed, on analysis, a continually decreasing quantity of calcareous matter. Now in this red ooze almost no calcareous forms were to be met with, and it was of extreme fineness, remaining for a long time in suspension in water, and proving on analysis to be almost pure clay, a silicate of alumina and the sesquioxide of iron, with a small quantity of manganese; and at this depth there appeared to be an absence of animal life.

Prof. Wyville Thomson considers it as quite proved that all the materials for such deposits, with the exception of the remains of those animals which are now known to live at the bottom at almost all depths, are derived from the surface;

and considering the very enormous extension of the calcareous ooze, it becomes important to know something of the minute foraminifera that produce it.

GLOBIGERINÆ.

In all seas, from the equator almost to the polar ice, the surface-water contains *Globigerinæ*. They are more abundant and of a larger size in warm seas; several varieties attaining a large size, and presenting marked varietal characters, are found in the intertropical area of the Atlantic. In the latitude of Kerguelen they are less numerous and smaller, while further south they are still more dwarfed, and only one variety, the typical *Globigerina bulloides*, is represented. The

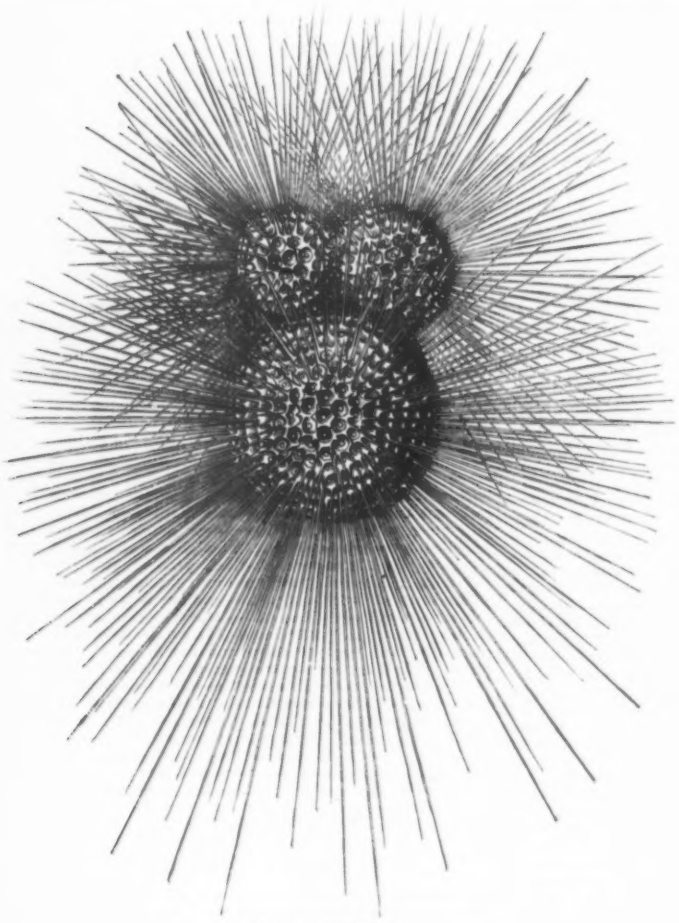


Fig. 2.—GLOBIGERINA.

living *Globigerinæ* from the tow net are singularly different in appearance from the dead shells we find at the bottom (Fig. 2). The shell is clear and transparent, and each of the pores which penetrate it is surrounded by a raised crest, the crest round adjacent pores coalescing into a roughly hexagonal network, so that the pore appears to lie at the bottom of a hexagonal pit. At each angle of this hexagon the crest gives off a delicate flexible calcareous spine, which is sometimes four or five times the diameter of the shell in length. The spines radiate symmetrically from the direction of the centre of each chamber of the cell, and the sheaves of long transparent needles, crossing one another in different directions, have a very beautiful effect. The smaller inner chambers of the shell are entirely filled with an orange-yellow granular sarcode; and the large terminal chamber usually contains only a small irregular mass, or two or three small masses run together, of the same yellow sarcode stuck against one side, the remainder of the chamber being empty. No definite arrangement, and no approach to structure, was ob-

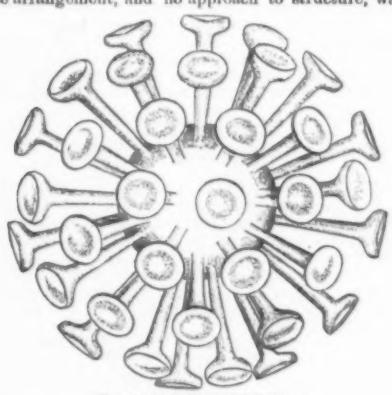


Fig. 4.—RHABDOSPHERE.

served in the sarcode; and no differentiation, with the exception of bright-yellow oil globules, very much like those found in some of the Radiolarians, which are scattered apparently irregularly in the sarcode, and usually one very definite patch of a clearer appearance than the general mass colored vividly with a carmine solution. The presence of scattered particles of bioplasm was indicated by minute spots here and there throughout the whole substance which received the dye.

When the living *Globigerina* is examined under very favorable circumstances, that is to say, when it can be at once placed under a tolerably high power of the microscope in fresh still sea-water, the sarcodic contents of the chambers may be seen to exude gradually through the pores of the shell, and spread out until they form a kind of flocculent fringe round the shell, filling up the spaces among the roots of the spines and rising up a little way along their length. This external coating of sarcode is rendered very visible by the oil globules, which are oval, and filled with intensely colored secondary globules, and are drawn along by the sarcode, and may be seen, with a little care, following its spreading or contracting movements. At the same time an infinitely delicate sheath of sarcode containing minute transparent granules, but no oil granules, rises on each side of the spines to its extremity, and may be seen creeping up one side and down the other of the spine with the peculiar *flowing* movement with which we are so familiar in the pseudopodia of *Gromia* and of the Radiolarians. If the cell in which the *Globigerina* is floating receive a sudden shock, or if a drop of some irritating fluid be added to the water, the whole mass of sarcode retreats into the shell with great rapidity, drawing the oil globules along with it, and the outline of the surface of the shell and of the hair-like spines is left as sharp as before the exodus of the sarcode.

ORBULINA.

There is still a good deal of obscurity about the nature of *Orbulina universa*, an organism which occurs in some places in large proportion in the globigerina ooze. The shell of *Orbulina* (Fig. 3) is spherical, usually about .5 mm. in diameter, but it is found of all smaller sizes. The texture of the mature shell resembles closely that of *Globigerina*, but it differs in some important particulars. The pores are markedly of two different sizes, the larger about four times the area of the smaller. The larger pores are the less numerous; they are scattered over the surface of the shell without any appearance of regularity; the smaller pores occupy the spaces between the larger. The crests between the pores are much less regular in *Orbulina* than they are in *Globigerina;* and the spines, which are of great length and extreme tenuity, seem rather to arise abruptly from the top of scattered papillæ than to mark the intersections of the crests. This origin of the spines from the papillæ can be well seen with a moderate power on the periphery of the sphere. The spines are hollow and flexible; they naturally radiate regularly from the direction of the centre of the sphere; but in specimens which have been placed under the microscope with the greatest care, they are usually entangled together in twisted bundles. They are so fragile that the weight of the shell itself, rolling about with the motion of the ship, is usually sufficient to break off the whole of the spines and leave only the papillæ projecting from the surface in the course of a few minutes. In some examples, either those in process of development, or a series showing a varietal divergence from the ordinary type, the shell is very thin and almost perfectly smooth, with neither papillæ nor spines, nor any visible structure except the two classes of pores, which are constant.

RHABDOSPHERES.

The Coccospheres and Rhabdospheres—these are suggested to be minute algæ forms—live on the surface, and sink to the bottom after death. Many of them are extremely beautiful, as will be seen from Figs. 4 and 5, representing two forms first discovered by Mr. Murray.

Taking the section from Teneriffe to Sombrero, first of all some 80 miles of volcanic mud and sand were passed; then some 350 miles of globigerina ooze; next about 1050 miles of red clay; then again a rising ground for some 330 miles of globigerina ooze, a valley of 850 of red clay; and nearing land some 40 miles of the globigerina ooze. Intermediate between the red clay and the globigerina ooze, a gray ooze was met with, partaking of the characters of both, and evidently a transitional stage. "There seems to be no room," writes Prof. Wyville Thomson, "left for doubt that the red clay is essentially the insoluble residue, the *ash*, as it were, of the calcareous organisms which form the 'globigerina ooze,' after the calcareous matter has been by some means removed. An ordinary mixture of calcareous Foraminifera with the shells of Pteropods, forming a fair sample of 'globigerina ooze' from near St. Thomas, was carefully washed and subjected by Mr. Buchanan to the action of weak acid; and he found that there remained, after the carbonate of lime had been removed, about one per cent of a reddish mud, consisting of silica, alumina, and the red oxide of iron. This experiment has been frequently repeated with different samples of 'globigerina ooze,' and always with the result that a small proportion of a red sediment remains, which possesses all the characters of the 'red clay.' I do not for a moment contend that the material of the 'red clay' exists in the form of the silicate of alumina and the peroxide of iron in the shells of living Foraminifera and Pteropods, or in the hard parts of animals of

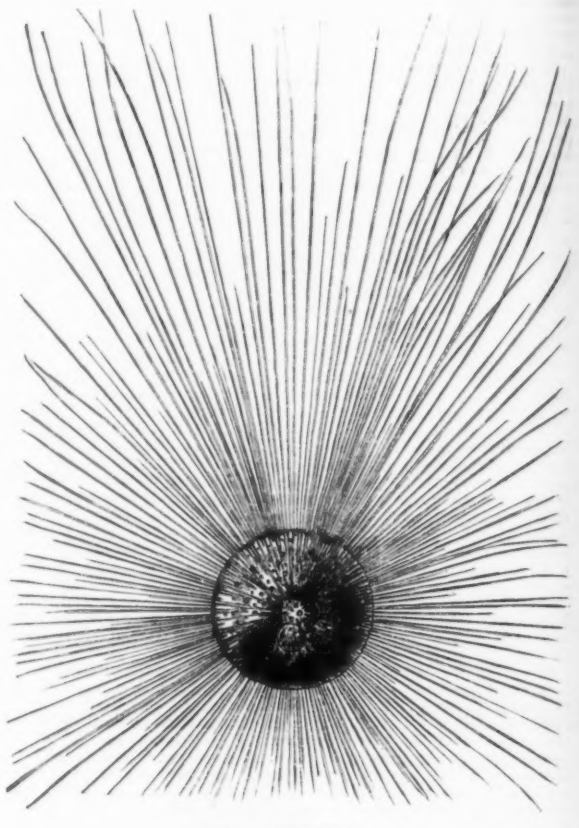


Fig. 3.—ORBULINA.

other classes. That certain inorganic salts other than the salts of lime exist in all animal tissues soft and hard in a certain proportion, is undoubted; and I hazard the speculation that during the decomposition of these tissues in contact with sea-water and the sundry matters which it holds in solution and suspension, these salts may pass into the more stable compound of which the 'red clay' is composed."

On this voyage Mr. Buchanan found the remarkable and unexpected result that the water has virtually the same specific gravity from the bottom to within 500 fathoms of the surface. From 500 fathoms the specific gravity rapidly rises

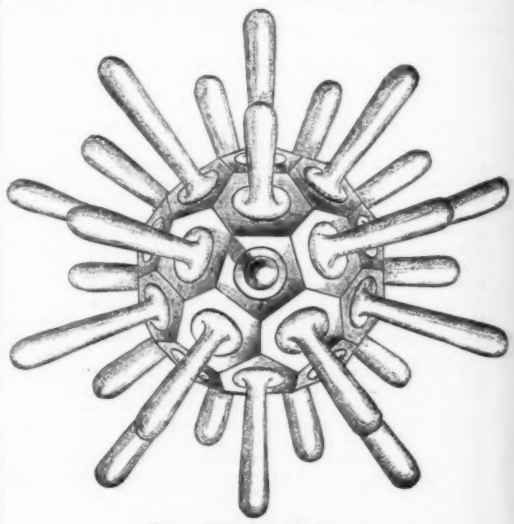


Fig. 5.—RHABDOSPHERE.

till it usually attains its maximum at the surface. Nineteen dredgings were taken, and these yielded a large supply of animal forms. It is unfortunate that in the deepest haul of all, 3150 fathoms, no living thing was brought up higher in the scale than a foraminifer; but this may be attributed to the nature of the bottom, an opinion borne out by the abundance, at scarcely a less depth, and on a bottom differing only in being somewhat less uniform, and containing sand grains and a few shells of foraminifera, of tube-building annelids of a very common shallow-water type. The crustacea do not appear to suffer from the peculiarity of the circumstances under which they live, either in development or in color. The singular fact of the suppression of the eyes in certain cases is already well known. The Echinoderms and sponges which enter so largely into the fauna of the zone ending at 1000 fathoms are not abundant at extreme depths.—*Nature.*